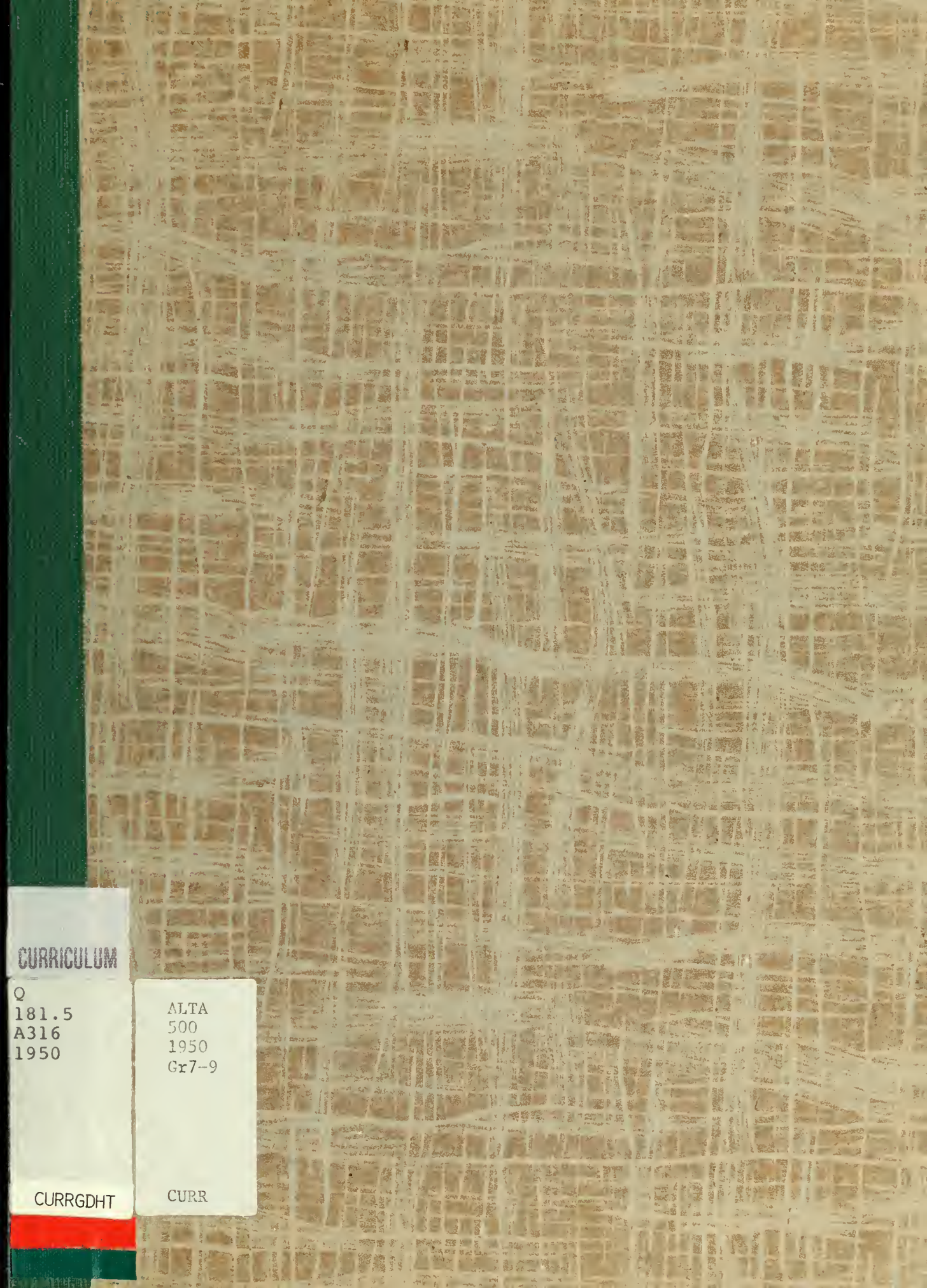

DEPARTMENT OF EDUCATION, ALBERTA

Program of Studies for the Junior High School

Interim

GENERAL SCIENCE PROGRAM

A Curriculum Guide for the Teacher

Prepared and issued by the Curriculum Branch
of the Department of Education, Alberta

September, 1950

Price 20 cents

INTERIM

GENERAL SCIENCE PROGRAM

FOR THE

JUNIOR HIGH SCHOOL GRADES

FOR 1950-51

"Advances in science when put to practical use mean more jobs, higher wages, shorter hours, more abundant crops, more leisure for recreation, for study, for learning how to live without the deadening drudgery which has been the burden of the common man for ages past.

"Advances in science will also bring higher standards of living, will lead to the prevention or cure of diseases, will promote conservation of our limited natural resources, and will assure means of defense against aggression....."

Vannevar Bush (Report to
Franklin D. Roosevelt).

September 1950

FOREWORD

Everyone is forced to admit that we live in a rapidly changing world as evidenced by the swift movement of scientific events of the last fifty years. The homes of our grand-parents had no telephones, electric lights, gas cook-stoves, bathrooms, running water, central heating, electric refrigerators, deep-freeze units, garages, fast automobiles, aluminum kitchen ware, factory canned foods, factory made clothes, radios, television, sulfa drugs, or vitamin tablets. No one travelled by air. The atom bomb and jet propulsion were unknown. Power machines were indeed rare.

Today the hand-operated tools are disappearing. Skilled operators handle precision instruments. Instantaneous communication removes the distances between national boundaries. Farm mechanization is causing farm folk to reside in cities while father and son return to the farm to seed and harvest the crop, without horses, and without the attendant chores.

If the school is to contribute to our modern welfare and social progress, it cannot remain static in a changing world. It must keep pace with social and technological advances in a world of the present by modernizing its methods in terms of a modern age. To fit a child for the world of yesterday would hinder his proper adjustment to our rapidly changing scene. In fact, to fit him for the world of today is short-sighted.

School training in the early days of our Canadian culture was planned to produce the conforming rather than the resourceful, straight-thinking individual. School practices of pioneer days, or even of a generation ago, are becoming out-moded.

Formal education tends to become withdrawn from the affairs of real living. The chief problem of education is not whether our schools should be formal or informal, conservative or progressive, but whether we are to establish in every community schools that will bring about the child's fullest development.

ACKNOWLEDGMENTS

The Department of Education acknowledges with appreciation the contributions of the following committee members to the preparation of this Junior High School Bulletin in General Science. The Bulletin has been prepared by the subcommittee on Junior High School Science under the guidance of the Junior High School Curriculum Committee.

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Grateful acknowledgement is extended to the Calgary School Board and to Dr. Buchanan for their cooperation in releasing committee members from school duties.

The first subcommittee prepared an interim program for the Junior High Schools of Alberta in 1949. This program served as a pilot experiment

and was tried out by a number of teachers in Edmonton, Calgary, and in certain selected schools in the various school divisions throughout the province.

The second subcommittee of 1950 prepared the present revision which is being made available to teachers of the province on an experimental basis in all Alberta schools during 1950-51 prior to its final adoptions in September 1951.

Teachers and superintendents are invited to submit to the Director of Curriculum suggestions and proposals for the final 1951 revision of the Junior High School Science Bulletin on the questionnaire at the end of this book.

Since this new program differs from the old one in content and approach it is hoped that teachers will study it carefully and critically in order that a thorough evaluation of the Bulletin may be made before the program is finally adopted.

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INTRODUCTION

The Importance of Science in the Total School Curriculum:

Science has a very direct bearing on our modern way of life. It has been largely responsible for the advancement of our Canadian civilization, and all phases of our living are influenced by the remarkable progress that science has made. In truth, our age is dominated by science. There are but few events in our lives in which we have not been helped and made more comfortable by the work of the scientist. Our problems of food, clothing, shelter, communication, transportation, production, distribution, consumption, conservation, health and safety have all been directly or indirectly related to science.

Everywhere in the world scientists are at work in their laboratories. The scientist has given us the airplane, the submarine, the ocean liner, the automobile and super-highways. Man's scientific knowledge is not only international but it is limitless, and the search for truth and for new information goes on indefinitely.

In our daily activities, from the time of rising until we go to bed, the scientist has helped us at every turn. The alarm clock that woke us up, the clean water with which we washed, the refined white sugar we put on our cereal, the bus we took to school or to work, the movie after four, the radio program at night, the pure milk we drank before retiring, have all been made possible by the scientist.

If boys and girls are to grow up as intelligent adults they must learn about science and the scientific method from their earliest years. Every person should learn how the scientist works, because new facts in science are constantly being discovered. The scientist changes his views regarding explanations based on past facts. Science is on-going and ever-searching.

Thus Alberta boys and girls must be made aware of the impact of science on their lives, because it is a vital force in their living. Modern youth must have a sufficient understanding of science to live wisely in our air age, in our atomic age. Citizens of today and tomorrow must possess a broad experience in science, must develop a scientific attitude or outlook, and must appreciate the contribution of science to our health, welfare, and comfort. In the process of science learning the student will acquire concomitant skills and information which should help to make him a better consumer and a better informed individual.

The reasons for including a study of science in the curriculum are obvious. Junior high school boys and girls have matured to the stage of adolescent interests. The newspaper, radio, and newsreel are replete with scientific items. Boys and girls work and play together in a scientific environment of cars, tractors, trucks, trains, wurlitzers, telephones and combination radios. In the bigger schools they organize extra-curricular activities, broadcast their school choir over the air, direct the school's public address system, handle the lighting effects for a stage performance,

repair household equipment and appliances, decorate the home for the Christmas holiday season, interpret camera exposure tables for their flash attachment. This is the twentieth century environment in which youth of today live.

The New Junior High School Science Program:

The junior high school science program is a new type of program. It consists of an organized progression of studies in a planned sequence from grades seven to nine inclusive. The program is an extension of major areas of study or of science experiences which the child has acquired in the Enterprises or Parallel Activities of the elementary grades. Throughout the junior high school science program the emphasis is on observing and experiencing as well as on the actual functioning or operation of science in the lives of boys and girls in the world about them.

The major importance of this course is not to master details of science content. The emphasis is rather to train youth in a way of thinking by engaging in actual problem-solving. Boys and girls must learn by direct experience the scientific way of thinking and acting: - defining a problem, collecting information, evaluating data, testing hypotheses, using experiments to solve problems, arriving at conclusions, and applying findings in later studies or action.

In addition to the scientific method, boys and girls will naturally develop a scientific attitude. Young children are curious; they ask why; they are eager to discover the new things and happenings about them.

In this course, the scientific method and the scientific attitude have been stressed all through the program. It is to be hoped that the method of straight-thinking, the inquiring attitude, the experimental outlook, and the open-mind will carry over into the child's senior high school grades, into university, and into life.

For science to be of value it must be put to use and to service. This course provides for experiences, experiments, trips, opportunities to know the world of living and non-living things, and studying and searching by individual and group methods.

It has been said that the use of scientific knowledge for the good of mankind, and its use for the shaping of our future living, can only be achieved if we have an understanding of the impact of science on our lives.

Reasons for Revising the Junior High School Science Program:

A program of studies in science must be related to the personal growth of the child, to his development of understandings, attitudes, and appreciations, to group activity, to clear thinking and expression, and to individual interests and abilities. Factual knowledge and skills in science

are by no means to be discarded but teachers must realize that understandings too are of critical significance. In fact, children cannot be taught to do straight and clear thinking in science unless they have acquired ability to develop general understandings.

It is felt that the unit study method of approach to general science learning is more effective in arriving at the broader purposes suggested above than is the type of program where science content is formally and logically set out in lengthy outlines of major headings and sub-headings, all in great detail. The unit study method is considered more effective in developing pupil skills, abilities, and understandings than the method of slavishly following a text-book based on an assignment-and-recitation technique.

The following reasons are proposed for revising the junior high school science program:

1. The need for a general overall plan of studies which will meet the needs of all pupils in Grades VII-VIII-IX.

2. The need to provide a progression, continuity, or sequence in junior high school science studies.

3. The need to provide a unity in the science work of the junior high schools.

4. The need to provide for the use of the problem-solving or scientific method in the treatment of a series of science studies.

5. The need to strengthen and enrich the teaching of junior high school science by
   (a) providing for the personal growth of the individual through group activity and behavior;
   (b) providing opportunities for the child to do original, creative, and clear thinking;
   (c) providing opportunities for pupils and teacher to work co-operatively together in planning studies and activities;
   (d) providing opportunities for self-expression and self-criticism;
   (e) providing opportunities for children to engage in research home-study in relation to a purposeful phase of a problem, as opposed to memoriter home study for re-citation to the teacher;
   (f) providing a democratic classroom situation in a group-activity-pattern involving problem-solving, rather than to have children sitting hour by hour in rigid seat arrangement listening passively to the teacher, or being asked questions;
   (g) providing opportunities for all pupils to participate in science studies according to their level of ability, maturity, and interest --- thus recognizing the psychological and commonly known principle of individual differences;

(h) providing opportunities to discover leadership abilities among a group of students;

(i) providing opportunities to challenge the very bright and keenly interested student by offering advanced readings and studies in line with his ability.

This Program Recognizes the General Trends in Science Teaching at the Junior High School Level:

This program has been planned to conform with the following general trends in junior high school science teaching:

1. A three-year science sequence which will meet the demand for science in general education.

2. A conscious attempt in better science programs to organize science learnings around a few broad and significant generalizations.

3. A conscious attempt to expand or enlarge the science understandings from grade to grade without repeating activities, illustrations, and science content.

4. A plan of organization centered around areas of interest. This practice is becoming almost universal.

5. A large-unit plan of studies built around the large areas of interest and related to the child's normal environment.

6. A series of activities in the form of interesting and worth-while readings, reports, and problem studies.

7. The constant use of the scientific method or problem-solving method and the continuous development of scientific attitudes.

8. A constant emphasis on the human or social implications of science and the application of the unit studies to our own living.

This Program Permits the Integration or Correlation of Broad Fields of Subject Matter at the Junior High School Level. Human knowledge and experience is a totality, a unity, rather than isolated bits of information. Under the proposed block system of scheduling, the fields of study in junior high school General Science may be readily correlated or inter-related with certain broad fields as follows:

(a) Science and English: The field of General Science lends itself well to the motivation and teaching of English language. The equivalent of one period per week will be devoted to the English of Science which will involve attention to correct expression, accuracy of statement, and

correct spelling. The teacher will often find that student interest is as great if not greater in science than in some phases of social studies and should make full use of science to give purpose to the child's self-expression in both oral and written English.

(b) Science and Social Studies: These two fields of study go hand in hand, the one strengthening the other in meaning and importance. Many items and units in this course are really socio-scientific in nature and the teacher will readily detect this interrelationship. For example, the obtaining of pure water, the setting up of our pure food laws, provincial regulations regarding health and sanitation are primarily social studies but their meaning cannot be fully appreciated without science understandings. The science of micro-organisms both harmful and beneficial, involves a study of such scientific controls as pasteurization, chlorination, refrigeration, sedimentation.

(c) Science and Mathematics: In certain units there are excellent opportunities to correlate these two fields. For example, in longitude and time studies, it is necessary to have a clear understanding of circular measure and to be able to make accurate computations.

(d) The Metric System: No special unit has been set aside for the teaching of the metric system. In order to be able to interpret readings in science texts and references, children need to know the meaning of cubic centimetres, grams, kilograms, etc. It is not necessary to teach the complete metric system but the teacher should take time from either the mathematics or the science periods to teach the essentials.

The Science Manual as a Guide to Teacher-Pupil Planning:

This science manual constitutes the science program for Alberta schools. It deals with the science activities for Grades VII-VIII-IX of the junior high school and is built on the sub-structure of science understandings that are the outcome of elementary education from Grades I-VI inclusive.

The manual has been designed to aid teachers in making science instruction meaningful and effective. It contains an overview of the science program, suggests the underlying philosophy, proposes content in relation to important concepts, indicates essential experiences, and provides reading references.

This Science Program is Flexible and Suggestive Rather than Prescriptive:

Although the overall pattern of unit studies on page 31 gives a suggestion of rigidity, it should be fully realized that the teacher is free to substitute alternative unit studies for those proposed in the grade-to-grade sequence. However, the teacher should not substitute studies that are not a phase of the physical or biological environment as shown under the Major Areas of Study in the overall chart on the left-hand side.

In other words, the organization and sequence of junior high school science content as SUGGESTED in the unit study outlines need not be followed rigidly and prescriptively by any or all science teachers. In fact, it would be rather tragic to find all teachers, ticking and checking off the suggested activities that have been listed in the various unit study outlines. The content of this manual should serve as a guide in making science vital and more operative in the lives of youth in YOUR PARTICULAR COMMUNITY.

Nor are all units to be covered in any one year. The number of units and activities dealt with in any particular class depends on the needs and interests of the particular group of students. A minimum of four and a maximum of seven units is suggested for any given year.

Under the unit-study method a problem should not be pursued any longer than interest span or value span will allow. Interests of boys and girls vary with geographical environment and with the topic in hand. No unit should be extended after interest has waned.

Articulation of this Program With the Science and Health of the Elementary and Senior High School Grades:

Referring to the overall pattern on page 31, it will be observed that the four major areas of science study are a direct extension of the science and health studies of the elementary grades. These four areas are:

LIVING THINGS
THE EARTH AND THE UNIVERSE
MACHINES, ENERGY, AND MAN
HEALTH AND SAFETY

The junior high school studies are but an extension or expansion of the elementary grade understandings connected with these four areas of our environment. It is expected that all children in Grades I-VI will have had an opportunity to experience directly these areas of science study either in their Enterprises or in the Parallel Activities. The junior high school program has been designed on the assumption that these foundations have been established. This is the basis of the EXPANDING CONCEPTS PHILOSOPHY.

Not only does the junior high school science program articulate or tie in with the elementary program but it also articulates with the general science and special science programs of the senior high schools. The general science program of the senior high school is mainly a physical science program so that the articulation in the senior high school becomes an extension of the studies of the EARTH AND THE UNIVERSE, and of MACHINES, ENERGY, AND MAN. The Biology course in the senior high school will extend the concepts gained in the junior high school science studies of LIVING THINGS.

The Importance of Committees and Sub-group Activities in Science Teaching:

This program has been organized on the basis of individual and group work in committees. Reading and report work, carefully directed by the teacher, is an important phase of the course. On occasion, the whole class may be given a uniform reading assignment but this will be for the purpose of a class discussion and not for reciting text matter to the teacher in class.

(a) Individual differences: It has long been known by parents and by teachers that children differ greatly, even in a given family, in their general ability, interests, and temperament. Despite this knowledge, our schools have continued for long under a pattern of mass instruction, completely ignoring the individual differences of the children in the total group. Little effort was made to adapt the program to the wide ranges in pupil capabilities.

(b) Enrichment for the interested: This course provides for the fullest possible development of all youth in the field of general science. Pupils should have opportunities to experience this full development in harmony with their individual talents, their readiness to assume responsibility, and their desire to cooperate with others.

(c) Enrichment for the very bright: Teachers should ever be on the alert for the challenging assignment which the bright student desires. The proposed activities in the various unit study outlines represent an "average". The teacher should be prepared to provide supplementary assignments for the enrichment of the brighter students. In the unit study outlines topics could have been suggested which would challenge the highly interested and alert child, but it was felt that such a plan might lead to a supposition that this material was for "common consumption". Thus, such topics as radar, television, electric dynamos and motors, the electric eye, infra-red and ultra-violet rays, finding direction by astral navigation, the principle of nuclear fission, electronics, electron structure of matter, have been omitted from the unit study outlines. Such topics may prove to be the type of investigation or additional activity that meet the needs of the best students.

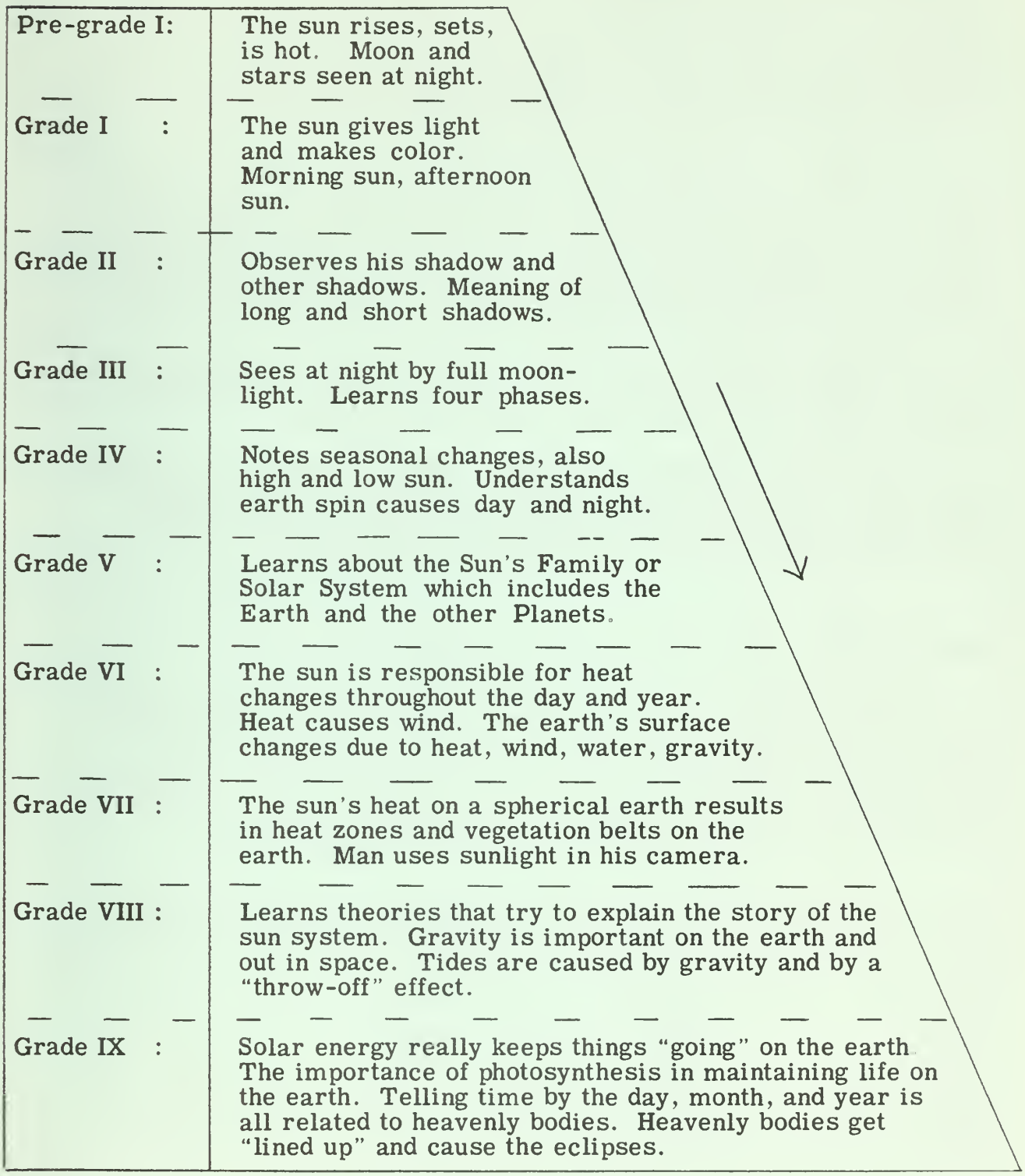
The Expanding of Concepts is the Basis of Organization in this Program:

This program is designed on an "expanding concepts" basis. By expanding or spiralled concepts is meant a continuity of experiences resulting from the ever-enlarging ideas gained by pupils in the study of their environment. These experiences take on an ever-widening meaning as the learner matures and as his interests change. The unit studies furnish a continuity of expanding ideas or concepts as the child progresses through the grades. Such concepts as Conservation of Resource, Adaptation of Life to the Environment, the Water Cycle are repeated in different and more complex situations from year to year in order to be understood by the maturing child.

As boys and girls grow up in a world of living things their experience in the physical and biological phases of their environment widens. They find that man, living in "his" universe, learns at least to control his earth environment and the plants and animals therein. They see that the earth's surface is changed by heat, cold, wind and rain. They see man harnessing different types of energy to suit his needs. They witness the progress made in scientific health practices. These major areas of study constitute the "threads" of science that course through the school grade studies in such a way that the child's understandings are enlarged and broadened.

Fig. 1 illustrates the expanding concepts idea or the extension of understandings that a child experiences when he thinks about the sun as a part of the universe. The simple understandings or direct experiences of pre-school years serve as a foundation for the work of the elementary school. The elementary grade school teacher broadens the base of understandings by seeing to it that the child's ideas will be expanded. His task is to so direct the child's science learnings that the junior high school teacher will in turn aid the child to expand and develop his previous understandings. As the child progresses through the grades new concepts or ideas are acquired and by the time the unit study work of the junior high school grades is completed, a solid foundation has been laid for the general or special science studies of the senior high school.

Fig. 1. - The Enlargement of Ideas (Expanding Concepts)
The Expanding idea of the Sun in the Universe.



Under the scheme of "expanding ideas" at the junior high school level, topics may be dealt with that appear both in the elementary and in the senior high school grades. It should be realized that this is to be expected under a spiralled or expanded plan of learning. In fact, this idea is not startling or particularly new. It has always applied in such subjects as mathematics, grammar, and even in the study of foreign languages. The main difference between this program and programs of the past is that there now exists a planned sequence of expanding ideas. No longer should anyone say that children should not learn the symbol for CO_2 in Grade IX because "this comes in Chemistry in Grade XI."

It should now be plain that certain major areas of study in science carry through not only from grades seven to nine, but in actuality from grades one to nine, and even beyond; in fact these areas of study carry right through into life. The study of living things, of the earth and the universe, of machines and energy, and of health and safety never stop when we leave school because these matters are "major areas of life," during school and after.

The overall pattern shows the four major areas sub-divided into seven divisions. These seven constitute the scope or large areas and these general themes or threads extend through all the grades.

THE TOTAL SCIENCE PROGRAM AIMS TO DEVELOP MAJOR CONCEPTS OR GENERALIZATIONS IN SCIENCE IN THE MAJOR AREAS OF: LIVING THINGS, THE EARTH AND THE UNIVERSE, MACHINES AND ENERGY, AND HEALTH AND SAFETY.

Summary of the Point of View in This Program:

In directing a science program that is based on an overall design of unit studies, it will be necessary for the teacher to use methods of instruction that emphasize group activity, committee work, teacher-pupil planning, direct experiences, excursions, experiments, reports, high standards of work, improved English expression, pupil willingness to assume a share of responsibility in working with others, pupil searching for information, and varied reference materials.

This program cannot be handled under a plan which interprets science learning in terms of pages to be covered in a text, or activities to be checked off in a suggested outline of a unit study. Teachers must realize that science learning is a matter of science appreciations, science attitudes, and science understandings. Such outcomes can only be achieved if teachers start with the child where he is or happens to be, both in regard to his immediate geographic environment, his community locality, his own level of maturity or growth, and his own personal background in the field of science. It is of the utmost importance that science understandings be acquired at all grade levels, hence the urgent need of including essential science in the work of the elementary grades.

Science is the organized extension of knowledge about man and his environment. THIS NEW SCIENCE PROGRAM IS CHARACTERIZED BY A METHOD OF PROCEDURE CALLED THE SCIENTIFIC METHOD. This problem-solving method by groups and individuals in association is the method of democracy and in life we meet it at every turn. It is the method of group-interaction with a goal or purpose in view.

There is no place for textbook teaching in this program. The unit study method stresses experiencing in an environment of things, life, materials, and happenings. The classroom is to become a place for group reading, doing, discussing, observing. The teacher should cash in on the native curiosity of adolescent and pre-adolescent youth.

Apart from the method or technique of problem-solving, scientific knowledge is essential in our age of science. Scientific developments have created new jobs for millions. Our natural wealth has increased. Our wants have multiplied. Science is important in peace and war. Science has given us increased leisure, happiness, and comfort. In this world of science the educated individual must be trained to think scientifically in the solution of personal, group, national, and world problems.

OBJECTIVES OF SCIENCE TEACHING

There have been many attempts made to define the aims of science education. We may state simply that the purpose of science teaching is to prepare youth to live well in a world of rapid change. Living well means to be healthy; to be a responsible citizen; to understand the world we live in; to appreciate the wonders of the world; to appreciate the use man makes of the gifts with which he has been provided. As life progresses from hour to hour and from year to year there are many scientific influences that direct and shape our lives. The aim of science teaching is to help people to adjust themselves to these scientific influences. In brief, science teaching aims to help us live more richly and more wisely in a scientific world.

Science teaching aims further to help people solve new problems that have arisen because of our scientific progress and our social development. Industry and science have given us the airplane, the automobile, the automatic telephone, and refrigeration, but these advances have resulted in numerous shocking accidents, strikes, and unemployment. Man's social problems must be attacked as seriously as have problems of scientific research which have given us so many conveniences.

Basic Needs of Youth Growing up in Our Canadian Culture:

If we were asked to list fifteen important needs of any growing boy or girl in our modern Alberta society the following might be considered significant:

1. Facing daily problems of life
2. Becoming dependable, self-responsible, and cooperative
3. Mastering the skills of communication
4. Acquiring healthy living habits
5. Developing the capacity of self-thinking and self-acting
6. Being critically-minded
7. Knowing our physical world
8. Planning for a vocation
9. Recognizing the operation of socio-economic forces
10. Being a competent family member
11. Being a competent citizen
12. Appreciating our young Canadian culture
13. Developing aesthetic appreciations
14. Developing spiritual concepts
15. Developing a philosophy of life.

It is suggested that a science program can contribute generously to such personal needs of youth.

The Four General Objectives of Education:

> "The ability to think reflectively and the disposition to do so in all the problem situations of life is an especially important educational objective. It is essential to adaptability, resourcefulness, and that type of self-criticism or stock-taking which leads to the continuing re-evaluation of personal beliefs and principles of action..... Young people will be helped to achieve these ways of thinking and acting only by wide successful experience in attacking and surmounting the problems with which novel situations confront them and in adjusting themselves accordingly....."
> (Quotation from Science in General Education - 1938).

What are these problem situations of life which call for adaptability and careful thinking? The answer to this question should tell us what the broad objectives of education are. In our democratic way of living, the individual is considered to be of supreme worth; therefore our educational system and our society should be prepared to develop the individual to his fullest possible extent. In other words, the main purpose of education is the development of the individual. Since the individual cannot "live unto himself alone", he must grow up in group situations, and one of the most important groups to which he must adjust is the family. Again, since each individual must earn a living, he must be prepared for a job, and since he must live in large social groups that are organized for the common good, he must develop into a good citizen. Therefore, the four functional or basic objectives of education are all related to the individual. They are:

1. Personal Development
2. Growth in Family Living
3. Growth Toward Competence in Citizenship
4. Occupational Preparation.

OBJECTIVES

1. Personal Development

   (1) Arousing a curiosity about things around us.

   (2) Developing ability to speak intelligently about our scientific progress.

   (3) Developing ability to compute with scientific measures.

   (4) Listening intelligently to addresses on scientific subjects.

   (5) Reading scientific articles and publications in magazines and periodicals.

   (6) Understanding those health and disease factors which contribute to our personal health and comfort and that of others.

   (7) Taking advantage of scientifically improved forms of recreation.

(8) Using leisure time wisely in a scientific world.

(9) Appreciating the painstaking and high quality work of the scientist.

(10) Exercising shrewd judgment in expenditures as a consumer.

(11) Exercising shrewd judgment in expenditures as a purchaser and knowing sufficient science to protect our interests.

2. Growth in Family Living

(1) Strengthening family life and making our homes more comfortable through the use of labor-saving devices.

(2) Training prospective parents in the art of home-making which today calls for understanding of scientific equipment and conveniences.

(3) Maintaining a democratic atmosphere in home and school by permitting all members to express opinions regarding problem situations of family and group life with proper respect for parents and elders.

3. Growth Toward Competence in Citizenship

(1) Desiring to bring social justice to all by providing scientific conveniences to all our people.

(2) Desiring to improve the unsatisfactory living conditions in our communities and in the nation.

(3) Searching for truth rather than surrendering to unscientific propaganda not based on fact.

(4) Developing a tolerant attitude toward the opinion of others based on willingness to weigh and assess facts.

(5) Appreciating the need for the scientific conservation of our natural resources.

(6) Measuring scientific advance in terms of the common good.

(7) Cooperating as a member of our scientific world community.

(8) Making decisions as a political citizen on legislation affected by science and technology.

4. Occupational Preparation

(1) Understanding the scientific knowledge and comprehension required in various types of jobs.

(2) Guiding the child toward an intelligent selection of an occupation which may possibly require scientific knowledge.

(3) Discovering and developing aptitudes for wise selection of life work.

(4) Improving efficiency by further study, which may involve an extension of scientific knowledge and understanding.

The Eight Specific Aims of Junior High School Science Teaching:

The four major or general objectives of education are divided into eight specific objectives which will apply directly in the treatment of the various unit studies of the junior high school program. These eight specific aims of science teaching are summed up in chart form in Fig. 2 below.

Fig. 2. - The Eight Specific Aims of Science Teaching

A: GENERAL LEARNINGS --	1. The General Use of Scientific Facts 2. The Development of General Ideas 3. The Ability to Apply General Scientific Principles
B: SKILLS & ABILITIES ---	4. The Ability to Apply Special Skills 5. The Ability to Use the Scientific Method
C: ATTITUDES, APPRECIATIONS and INTERESTS	6. The Development of Scientific Attitudes 7. The Development of Scientific Appreciations 8. The Development of Scientific Interests

Because of the fact that aims and objectives of science instruction are often printed in programs of study but poorly interpreted, each of the eight specific objectives of science will now be examined carefully.

Objective 1: The General Use of Scientific Facts and Information that Are Operative in Our Daily Living. Science information and science facts become significant only if related to other information about our living. It is expected that students will build up a good scientific vocabulary and use it effectively. They should be able to use facts in writing about scientific data, always expressing themselves accurately and well. The science program provides an abundance of factual knowledge in problem-solving situations. Facts should be relevant and meaningful to be of greatest value. For example, to state that water freezes at 32 degrees Fahrenheit is a fact but the relevance of this fact to the freezing of a large portion of our Alberta wheat crop, or to the freezing of plants and flowers in our home gardens is what gives it meaning. The figure 32 on a thermometer outside our window determines whether or not we shall spend two hours covering plants against a coming frost, or whether the fruit losses in parts of California will raise the cost of fruit imported into Alberta. Again, facts about plants. animals, the earth, the sun, the stars, the weather, machines, energy, operate in the daily living of our modern society. A knowledge of these facts carries over into life and contributes to intelligent living and intelligent citizenship.

Objective 2: The Development of General Ideas Regarding the Subject Matter of Every Day Science. From the great mass of reading and study material in the science program much of the concrete detail will be forgotten, but a small general residue remains. These generalized ideas, often called major or core ideas, become the general or basic concepts that are finally left in the child's mind. The richer his problem experiences, the clearer will be the general idea that he retains. Mere memorization of science data without understanding leads to a very fuzzy concept or to no general idea at all. Real knowledge of science is to be found in the clear understanding of the major principles of science because they are the concepts that determine our comprehension of science studies.

In each unit there are to be found a small number of these fundamental concepts which operate in our living. For example, the concept that energy can be changed from one form to another is operative in the Alberta hydro-electric power plant at Seebe, or for that matter, in any domestic kitchen. The general idea brings to mind a great many concrete facts or particular ideas.

The importance of even a partial understanding of such a general idea as "Space is Vast and Time is Endless" may lead children to establish such a strong appreciation of the generalization, that they will ultimately develop a sound philosophy of life. This general idea may lead to a strengthening of one's religious convictions, or develop an idealistic way of thinking about the relation of our lives to the universe in general.

Objective 3: The Ability to Apply General Scientific Principles in Our Daily Living. The laws of science are often simple but they are always universal. An object dropped from above ground, or a plane that runs out of fuel in the upper air, will fall to the ground in Russia, Alberta, Ottawa, everywhere. The law of gravity is universally true.

A fine wire carrying an electric current gets hot. Under control in a toaster, all is well. But in the attic of your home, or on the top of a high-voltage transmission tower or electric light pole, it can cost us our lives.

The simple principle that living things reproduce their kind is recognized readily by the farm child who is thrilled when a litter of pigs is born, or by a city child when a wee cocker spaniel puppy arrives in the home.

The science program contains numerous examples of principles which are of value and meaning to us in our daily living.

Objective 4: The ability to apply such skills as reading, computing, graph work, chart work, making accurate measurements to handle scientific equipment, all or any of these may apply in the various science unit studies, or possibly later in one's vocational occupation.

Pupils should be encouraged to display initiative and resourcefulness in the solution of the science problems in this course. We can all recall the type of classroom atmosphere where children sat passively in their rows of seats depending completely on the textbook and the teacher.

This course will give the children freedom to move about, to work in committees, to perform varied activities suited to their ability levels, and to make use of several sources of information. Pupils will work from books, perform experiments, take field trips, construct models, make collections, and read, write, and listen. By means of class discussions pupils will learn to express themselves clearly, and will contribute their experience and knowledge to the unit study being investigated, and will in turn benefit from the experience and knowledge of others in the group. Science studies will provide training in other skills such as the making of accurate measurements, accurate computations, reading and interpreting maps, graphs, charts, and tables, and the careful manipulation of laboratory materials. Students should realize that in life, careless measurements and computations in the design of a bridge or overhead railway may bring very disastrous results and heavy loss of life.

Objective 5: The Ability to Use the Scientific Method of Problem-solving in the Classroom, in the Laboratory, and in our Social Living. Many of our great social advances are credited to the scientist and to his problem-solving method. The Panama

Canal was made possible by scientists combating the mosquito. Modern sanitation in our towns and cities relies on scientific methods of water purification and the social control measures set up by our departments of health. The method of investigating the irrigation and conservation problems in our "dust-bowls" is an example of applying science and the scientific method to the solution of cooperative social undertakings with a view to bringing greater comfort and happiness to a greater number of people. Other examples of the use of the scientific method in our social living are to be found in the elimination of fire and traffic hazards, preventing the spread of disease, flood control, pure food laws.

The science course is centered around the scientific method of problem solving. This special skill is to be achieved under a democratic plan of group membership and group activity. The teacher should realize that THE PROBLEM-SOLVING METHOD IS THE CRUX OF THE PROGRAM. Teachers are encouraged to use their initiative and imagination in applying the unit study method to suit the local classroom situation. In the solution of any unit study it is necessary to make use of all available materials and ideas in arriving at a definite conclusion to the problem study under investigation.

If teachers who work with this new program can only realize that the scientific method, the problem-solving technique, the unit study, and the democratic classroom environment or atmosphere, all have a great deal in common, they will have caught the spirit of the program.

The problem-solving method merely involves the following:

A. A PROBLEM ARISES: Curiosity (individual and group), and approach to the problem.

B. TRYING TO SOLVE THE PROBLEM: Gathering facts, suggesting, experimenting, evaluating, testing, etc.

C. CONCLUSIONS TO THE PROBLEM: Results established, tentatively established, and not established; best answers in the light of our present knowledge; maintaining an open-mind in the future; applications in our living.

Objective 6: The Development of Such Attitudes as Open-mindedness, Suspended Judgment, Critical Thinking, Intellectual Honesty, and Reverence are Outcomes of the Use of the Scientific Method.

The attitude of open-mindedness, even in the face of what appears to be a final conclusion is exemplified in one's willingness to consider new facts. New discoveries bring new facts to light which may force us to alter our first tentative conclusions.

Who knows if we will ever be able to reach the moon or Mars? Who knows if telepathy will ever be possible or not?

The attitude of suspending judgment is exemplified in the readiness to withhold conclusions until all available facts are in, or when we avoid a sweeping generalization from insufficient data.

The attitude of thinking critically by viewing all sides of a question, or not arriving at conclusions unless we have sufficient evidence, is an important outcome of science teaching. It is our hope that the newly-discovered atomic energy will be of great service to mankind. It is unscientific to say that its discovery is the beginning of the end of our civilization. It is likewise unscientific to say that students do not spell or figure as well as their fathers. We must get the facts before we can say that such a statement is true.

The attitude of reverence is bound to arise in such a study as the vastness of and order in the universe. So too may reverence arise in many other areas of science to the extent that there should be no quarrel between religion, philosophy, and science. The way in which "nature" causes life forms to be dependent on non-life materials is cause for reverence. The fortunate provision that nature makes in seeing to it that water contracts when it cools down to a certain temperature and then begins to expand, makes it possible for aquatic life to live in water during the winter. Or, again, simply remove our sun from the solar system and we are doomed! Remove our blanket of air and life ceases! Remove the gravitational forces between earth, sun, moon, planets, stars, and where are we? Beneficent "nature" provides life cycles, water cycles, nitrogen cycles, carbon cycles. The continuity of life, the energy of the atom, life in the cell, and unity in the Universe -- ALL these make us stand in awe! Reverence is indeed a logical outcome of the study of science in its many phases.

Objective 7: The Development of Appreciations is a Result of Science Teaching. As students work together in a cooperative classroom atmosphere, habits should develop which should assist them to appreciate the fact that individuals in such a classroom must learn to get along with each other and to have a mutual respect for others and for their opinions. In adult life, peaceful living with our community, national and world neighbors is but an extension of the same principle as that experienced in group activity in the classroom.

In this process of democratic classroom living, each individual must recognize the need for group regulations comparable to regulations of our adult society. The individual has responsibilities to the group as well as to himself.

Each individual must learn to "play the game" and contribute his share in the solution of the problem being dealt with. As adult citizens, they will later be expected to contribute their share to the improvement of their community and the Canadian way of life.

Science lends itself well to the development of an appreciation of the value of peace and the horrors of wars. Science is a contributor in both peace and war. Our permanent army, navy, and air force are highly mechanized and are built on a foundation of scientific achievement and scientific research. Boys and girls must be made to realize the utter wastefulness of war, even to the victors. The teacher should endeavor to instil in the minds of youth the joy of peaceful living, the satisfaction resulting from a Christian and a democratic way of life at the local and the world level.

Appreciation of cause-and-effect relationships is to be found in such studies as the wind systems of the world, land and sea breezes, cyclones, chinooks, the theories of the birth of the earth, the disappearance of dinosaurs, and so on.

Appreciation of the contribution of the scientists to our human welfare and happiness is self-apparent. Youth should appreciate the efforts of the research scientist working away patiently with his scientific method in his scientific laboratory, seeking cures for our ills, experimenting with new forms of energy for our machines, trying out new labor-saving devices, and searching for ways to extend the life span. The special unit on Health Through the Ages will reveal much information on the progress of health science and will serve to develop an appreciation of the accomplishments of the scientist, the inventor, the research worker, and others.

Appreciation of the scientific method as a means of dealing with many of our social and economic problems. The Winnipeg flood control is an example of a social issue on a national scale. Our own experiment in national living is referred to as social democracy, and has been a trial-and-error affair through the years. It is the best way of living we know to date, despite its ills and its need for improvement here and there.

Objective 8: The Development Among Boys and Girls of an Interest in Science. The development of an interest and a curiosity in science may lead directly to hobby or avocational pursuits. In a world where leisure time is increasing, spare-time activities are becoming more and more essential. Reading of scientific books and periodicals, photography, a home-chemistry laboratory, operating a public address system, and studying television, are fascinating to young children and these challenging interests may lead to a life-time hobby or serve as occupational preparation.

General Comment on the Eight Specific Objectives:

It should be borne in mind that these outcomes or objectives are not referred to in each of the units of study outlined in this program. It is left to the teacher to see that these broad outcomes are achieved in each and every unit.

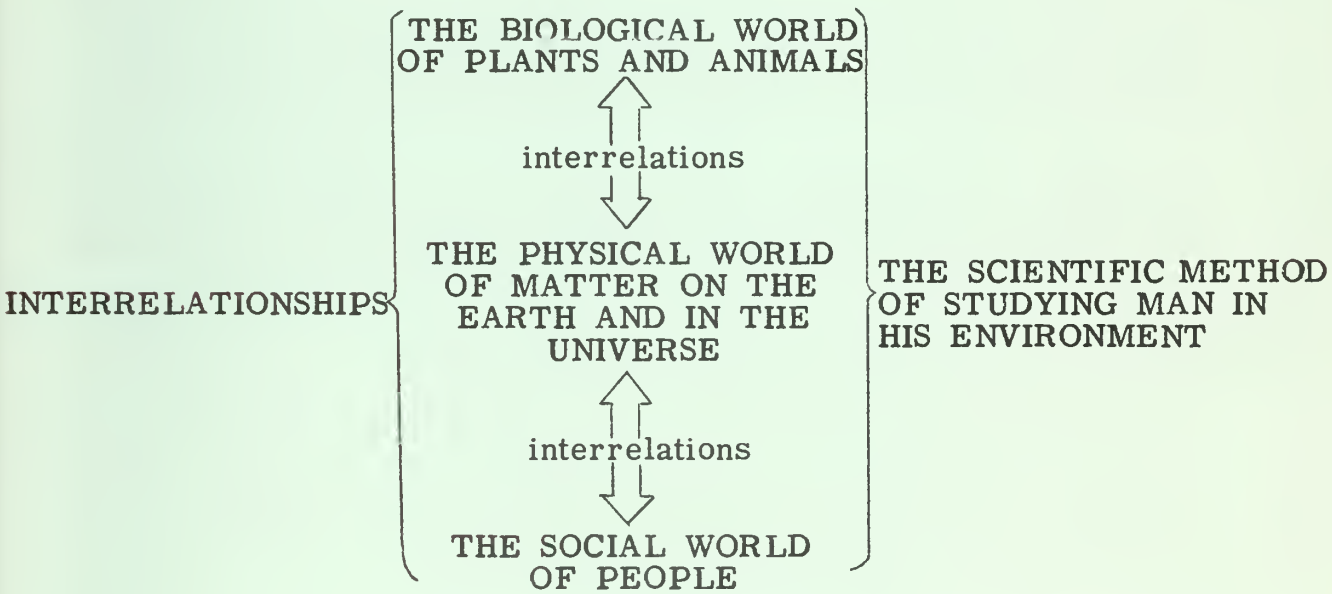
In brief, this entire section may be summed up by saying that: THE AIM OF SCIENCE TEACHING IS TO DEVELOP A CRITICAL-THINKING PERSON. This requires facts to think about, having ideas or opinions, applying principles, using special skills, thinking scientifically, possessing scientific attitudes and appreciations.

THE SCIENCE PROGRAM FOR JUNIOR HIGH SCHOOLS

The General Theme of Interrelationship:

Coursing through the entire junior high school science program is the theme of INTERRELATIONSHIP BETWEEN LIVING AND NON-LIVING THINGS IN A UNIVERSE OF UNKNOWN AMOUNT OF ENERGY. This energy man has harnessed to a remarkable degree, but future developments and potentialities are an unknown quantity. The energy of lifeless or inert matter knows no bounds. The teacher and pupils should endeavour to detect this single theme of interrelationship running throughout the entire pattern of unit studies. Thus the total environment, biological, physical, and social, becomes the stage setting for the various unit studies. Fig. 3 should help to make this interrelationship concept clear.

Fig. 3. - The Concept of Interrelationship Between Living and Non-Living Things



Basic Principles of Design in the Junior High School Science Program:

In planning the science program, certain guiding principles were agreed upon as fundamental and these principles were used as criteria for the organization and selection of materials for the course. In order to have a proper appreciation of the framework or structure of the program these principles are now outlined.

1. The Principle of Large Areas of Study: The course is organized around certain large areas of our biological and physical environment. These Areas of Science Study are found to the left of the overall chart, page 31, and are often referred to as the scope of the program. These major areas of study are four in number, namely: Life, The Earth and the Universe, Work-Energy-Machines-Man, and The Science of Health and of Safe Living. The overall chart shows these four areas broken down into seven major divisions of science study, namely: Variety of Life, Adaptation and Interdependence, Space and Time, Change, Man's Control of His Environment, Man's Use of Magnetism and Electricity, and Scientific Health. The grade to grade studies under these various areas of the scope are handled in a series of unit studies and not under a compartmentalized subject matter treatment of physics, biology, and chemistry, nor under a text-book topical plan. The "scope" is really the "what" of the course.

2. The Principle of Progression or Expanding Concepts: The course is so planned that students will experience a progression of difficulty as their understandings of the scope items are expanded according to their increasing maturity and growth from grades seven to nine. This progression or extension of treatment is often called the sequence. The "sequence" is really the "when" of the program.

3. The Principle of the Unit Method: The course must be handled by the unit-study method throughout. Each section of the overall chart on page 31 constitutes a unit, which will require approximately a month to complete. There are twenty-one units of study in the total junior high school course.

4. The Principle of Analysis: Each of the twenty-one units of the junior high school program has been outlined in order to show how the problem-in-hand might be analysed into a variety of activities to allow for individual differences of pupils in any given class or grade.

5. The Principle of Directed Group-Planning: Each unit calls for co-operative group planning between teacher and pupils. A certain amount of pre-planning and thinking about the unit should be done by the teacher before the unit is introduced. As soon as the unit starts, however, preliminary work on how to carry out the unit begins. Progressive planning and revision take place as the unit develops. Finally, ideas are proposed to close off the unit and to appraise the total planning that was used to carry out the unit.

6. The Principle of Broad Outcomes: This science program provides for the achievement of broad outcomes as contrasted with the single and narrow outcome of traditional science teaching which emphasized factualism only. No one will dispute the fact that the acquisition of definite and well-ordered information is a valuable outcome of learning but it should be remembered that the development of good habits of thinking, of sound attitudes and appreciations, and of general understandings are at least of equal concern.

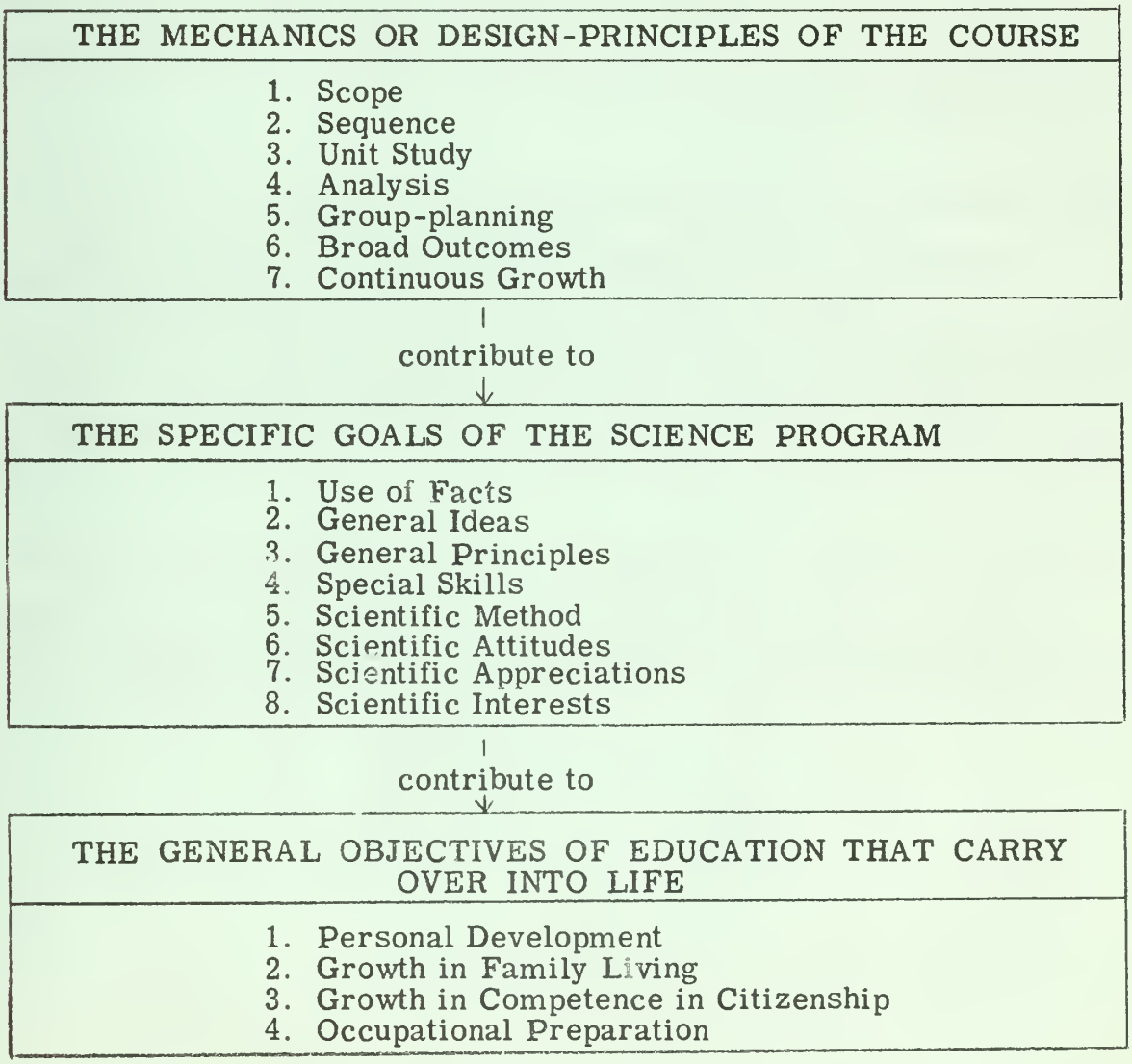
   It is essential that adequate and exact science information be

included in the program. The unit method merely places the acquisition of factual information secondary to the process of acquiring it. Furthermore, the unit method provides for the development of ability in the use of the scientific method with its related concomitant outcomes of learnings, skills, abilities, and appreciations.

7. The Principle of the Continuous Growth of the Learner: The child's learning must be continuous. The units are arranged in a progressive and continuous sequence through the grades. The earlier units are generally simpler and more direct than the later ones because ninth grade youth have had richer experiences and greater maturity growth than grade seven students.

Fig. 4 shows the contribution of design principles to specific and general objectives of the course.

Fig. 4. - The Contribution of Design Principles to the Specific and General Objectives.



The Overall Pattern of Unit Studies:

The overall pattern of unit studies for each of the junior high school grades is shown in Fig. 5. It consists of seven units or major areas of scope in each of the three grades. The progression of the units through the grades is shown in each of the rectangular spaces under each grade heading.

It is felt that each of the units contains significant content the study of which will result in the attainment of the specific and general objectives of science. The content material should be appropriate to the level of understanding of junior high school pupils and should challenge their interest. Every attempt has been made to relate the content material to the present living of the students and their experiences in an Alberta environment. The principle of variety of learning activities has been kept to the forefront throughout the unit studies.

About twenty-five or thirty experiments should be planned for each of the junior high school grades. An endeavor has been made to maintain a balance in the number of experiments from grade to grade. The industrious teacher may add more or have fewer experiments as he sees fit according to his particular class group.

This Program is Built on the Elementary School Science Foundation:

It is expected that elementary grade pupils will have developed certain general understandings and appreciations in connection with their studies of Living Things, The Earth and the Universe, Energy and Machines, and Health. The overall chart for junior high school science makes it apparent that the major areas of science study in junior high school articulate well with and form an extension of elementary school science learnings. Fig. 7 shows the articulation between the elementary and junior high school science programs.

The Scope of the Elementary and Junior High School Science Programs:

It is noted in the tabulation below that the seven items of the scope for junior high schools is but an expansion of the science treatment expected in the elementary grades. The seven scope items are as follows:

Fig. 5. SCOPE AND SEQUENCE CHART OF UNIT STUDIES IN JUNIOR HIGH SCHOOL GENERAL SCIENCE

PROGRESSIVE TREATMENT OF THE AREAS OF SCIENCE STUDY THROUGH THE GRADES (Sequence)					
AREAS OF SCIENCE STUDY (Scope)	THE FOUR MAJOR DIVISIONS OF SCIENCE STUDY	Subdivisions of Science Studies	GRADE VII UNITS	GRADE VIII UNITS	GRADE IX UNITS
	A: LIFE	1. VARIETY OF LIFE: There are many forms of life.	VII-1: ANIMALS: A BRIEF STUDY AND SIMPLE CLASSIFICATION.	VIII-1: PLANTS: A BRIEF STUDY AND SIMPLE CLASSIFICATION.	IX-1: PLANTS AND ANIMALS BASIC TO ALBERTA'S AGRICULTURE.
		2. ADAPTATION & INTER-DEPENDENCE: Life depends on and adjusts to living and non-living things.	VII-2: LIVING THINGS ARE ADAPTED TO THEIR ENVIRONMENT FOR PROTECTION AND FOOD-SEEKING.	VIII-2: INTERDEPENDENCE OF "LIFE-AND-LIFE" AND OF "LIFE-AND-NON-LIFE"	IX-2: NATURAL AND ARTIFICIAL IMPROVEMENT OF ECONOMIC PLANTS AND ANIMALS.
	B: THE EARTH AND THE UNIVERSE	3. SPACE & TIME: Space is vast and time is endless.	VII-3: BEYOND OUR SOLAR SYSTEM.	VIII-3: WITHIN OUR SOLAR SYSTEM.	IX-3: THE EARTH'S MOVEMENTS AND RELATION TO TIME TELLING.
		4. CHANGE: The earth's surface is being continually altered.	VII-4: THE STORY OF THE EARTH'S FORMATION.	VIII-4: THE EARTH'S "COVER": WEATHER AND EROSION.	IX-4: CONSERVATION OF THE EARTH'S RESCURCES.
	C: WORK, ENERGY, MACHINES, AND MAN	5. MAN'S CONTROL OF HIS ENVIRONMENT: Man is inventive or scientific.	VII-5: IDENTIFYING SIMPLE MACHINES.	VIII-5: MAN'S USE OF ENERGY.	IX-5: MACHINES AND THEIR SOCIAL IMPLICATIONS.
		6. MAN'S USE OF MAGNETISM & ELECTRICITY: Man is an experimenter in the field of electricity.	VII-6: MAGNETS AND THEIR USES.	VIII-6: PRODUCTION OF ELECTRICITY AND ITS DISTRIBUTION IN THE HOMES.	IX-6: ELECTRICITY IN OUR DAILY LIVING.
	D: THE SCIENCE OF HEALTH & OF SAFE LIVING	7. HEALTH SCIENCE: Man plans for his protection and safety.	VII-7: HEALTH SCIENCE THROUGH THE AGES.	VIII-7: MICRO-ORGANISMS, BENEFICIAL AND HARMFUL.	IX-7: ACCIDENTS AND FIRST AID.

Fig. 6. SUBJECT AREAS INCLUDED IN THE SCOPE AND SEQUENCE OF UNIT STUDIES IN JUNIOR HIGH SCHOOL GENERAL SCIENCE

PROGRESSIVE TREATMENT OF THE AREAS OF SCIENCE STUDY THROUGH THE GRADES (Sequence)					
AREAS OF SCIENCE STUDY (Scope)	THE FOUR MAJOR DIVISIONS OF SCIENCE STUDY	Subdivisions of Science Studies	GRADE VII UNITS	GRADE VIII UNITS	GRADE IX UNITS
	A: LIFE	1. VARIETY OF LIFE: There are many forms of life.	VII-1. BIOLOGY	VIII-1. BIOLOGY	IX-1. ECONOMIC AGRICULTURE
		2. ADAPTIONS & INTERDEPENDENCE: Life depends on and adjusts to living and non-living things.	VII-2. BIOLOGY	VIII-2. BIOLOGY	IX-2. BIOLOGY
	B: THE EARTH AND THE UNIVERSE	3. SPACE & TIME: Space is vast and time is endless.	VII-3. ASTRONOMY	VIII-3. ASTRONOMY	IX-3. EARTH SCIENCE
		4. CHANGE: The earth's surface is being continually altered.	VII-4. GEOLOGY	VIII-4. GEOLOGY	IX-4. CONSERVATION
	C: WORK, ENERGY, MACHINES, AND MAN	5. MAN'S CONTROL OF HIS ENVIRONMENT: Man is inventive or scientific.	VII-5. PHYSICS	VIII-5. PHYSICS	IX-5. SOCIO-PHYSICAL SCIENCE
		6. MAN'S USE OF MAGNETISM AND ELECTRICITY: Man is an experimenter in the field of electricity.	VII-6. PHYSICS	VIII-6. PHYSICS	IX-6. SOCIO-PHYSICS
	D: THE SCIENCE OF HEALTH & OF SAFE LIVING	7. HEALTH SCIENCE: Man plans for his protection and safety.	VII-7. HEALTH SCIENCE	VIII-7. HEALTH SCIENCE	IX-7. HEALTH SCIENCE

SCHOOL GRADES		ELEMENTARY	JUNIOR HIGH	SENIOR HIGH
		I, II, III, IV, V, VI	VII, VIII, IX	X, XI, XII
SCIENCE		1. Living Things	1. Life	1. Biology
		2. Earth and the Universe	2. Earth and the Universe	2. Physical Science
		3. Energy and Machines	3. Work, Energy, Machines, and Man	3. Physical Science
	HEALTH	4. Health	4. The Science of Health and Safe Living	4. Health

Fig. 7. Diagram to show articulation between the elementary, junior high school, and senior high school science program.

Seven Areas of Scope

1. Variety of Life
2. Adaptation and Interdependence
3. Space and Time
4. Change
5. Man's Control of His Environment
6. Man's Use of Magnetism and Electricity
7. Scientific Health

The overall chart shows that these seven areas are grouped under four headings comparable to areas of study in the elementary school grades. These grouped divisions are:

Grouped Divisions of Study

A. Life
B. The Earth and the Universe
C. Work, Energy, Machines, and Man
D. The Science of Health and Safe Living

Major Understandings That Might Be Expected in Each Area of the Scope:

A. Life:

1. All life forms need food and must have a place to live.
2. Plants and animals are useful to man.
3. All life forms adapt to their environment.
4. All life forms have ways to protect themselves.
5. All life forms can be grouped according to characteristics.
6. All life forms reproduce.
7. Man improves plants and animals.
8. There is an interdependence among life forms.
9. All life forms experience some struggle.

B. The Earth and The Universe:

1. Space is vast and time is endless.
2. All energy is traceable to the sun.
3. The order in the universe and the movement of heavenly bodies is due mainly to gravitational attraction.
4. Life on the earth from pole to pole varies because of the earth's position in relation to the sun.
5. Natural forces are changing the earth's appearance.
6. In ages past, great climatic changes took place.
7. The earth is very old in terms of our ideas of time.

C. Work, Energy, Machines, and Man:

1. Man invents ways to bring us greater comfort and happiness.
2. Man invents machines to do his work more easily.

3. Big machines are made up of simpler machine types
4. Magnetism and electricity have modernized our living.
5. Energy can be transformed but not created nor destroyed.
6. Physical and chemical changes require energy to bring them about
7. Man's group living is influenced by his biological and physical environment.
8. The radiant energy of the sun supports life on the earth.

D. The Science of Health and of Safe Living:

1. Health science (scientific research) has replaced health magic and health superstition.
2. The scientific method has been used in health research.
3. Our lives are affected by minute or microscopic forms of life.
4. Health and safety are both an individual and group concern.
5. Accidents increase as civilization becomes more complex.
6. First aid is a matter of scientific knowledge.
7. First aid is a matter of Christian charity.
8. The advances in medical science are due to a long line of scientific research workers.
9. We have faith in the future of health science.

Time Allotment to General Science in the Junior High School:

In many schools, mathematics and science will be taught by the same teacher. These two fields may be integrated or interrelated. The time allotment to mathematics and science in the junior high school grades is eight to twelve periods per week. These periods are to be set up in the daily schedule under a system of block scheduling. The mathematics-science block may be considered a unit of the schedule. Science will receive from four to six periods per week and mathematics four to six periods per week.

In the broad field or area of General Science, pupils will be expected to devote time to the reading, writing, and spelling skills in science. In fact teachers should set aside the equivalent of one science period per week for attention to these correlated skills.

It should be noted that the time devoted to science is slightly in excess of that found in the previous science program. The justification for this time increase is as follows:

1. The increasing importance of science in modern living.
2. Inclusion of the strictly scientific phases of health and safety education.
3. The contribution which general science should make to the general education of all youth.
4. The need for increased emphasis on the communication skills of science.
5. The fact that it requires time to develop in students a critical and questioning attitude.

The Cycling-Plan for Combined Grades VII and VIII:

In Alberta schools, enrolments are often so small and the teacher load so varied and great that a certain amount of cycling of the program is often necessary.

In the larger city and town schools it is preferable not to cycle any of the course content. However, where Grades VII and VIII are found together in one classroom these two grades may be grouped and their programs cycled. That is to say, the sequence or progression of studies in Grades VII and VIII are covered in two years. Grade IX is not to be cycled with other junior high school grades.

The cycling scheme may be made clear by referring to the overall chart on page 31 and to the cycle table below:

CYCLE A: 1950-51 (Combined Grades VII and VIII)		CYCLE B: 1951-52 (Combined Grades VII and VIII)	
Units:	VII-1	Units:	VIII-1
	VII-2		VIII-2
	VII-3		VIII-3
	VII-4		VIII-4
	VII-5) *		VII-6) *
	VIII-5) *		VIII-6) *
	VII-7		VIII-7

(*) Note that the units on "Identifying Simple Machines" (VII-5) and "Man's Use of Energy" (VIII-5) must both be taken in any one year because foundation learning acquired in the grade VII unit is required for the proper understanding of the Grade VIII unit. In other words, these two units cannot be cycled in the true sense of the term. The same argument for non-cycling applies to the units on "Magnets and Their Uses" (VII-6) and "Production of Electricity and Its Distribution in the Home" (VIII-6). Hence these units must also be taken together in any one year.

The Science Program is not a Prescriptive Program:

This general science program is designed to permit each child or group of children to develop according to individual talent and group interests. The actual science content for each unit will vary from group to group and with individuals in class groups. Pupil interests, maturity or growth level, and the nature of the community are different in every classroom. The school location in each of the geographical divisions of the province and the season of the year will also affect the treatment of the unit studies. Teachers know that pupil experiences and interests will vary widely in rural and urban areas, and in prairie, parkland, bush, and mountain areas of Alberta. Children reared in a forested region around Fort Vermilion will have different experiences from those who grow up in the sugar beet area around

Raymond or Magrath. This latter statement is bound to have an effect on all the unit studies but especially on those units found under divisions A, C, and D of the scope (see overall chart, page 31).

The course purposely avoids rigidity. No attempt has been made for example, to outline all the detailed objectives expected in any one unit of the course. However, the major ideas or generalizations, representing desirable understandings that should result from the unit, have been stated in the unit outlines. A good formula to remember at all times is: "ADAPT BUT DO NOT ADOPT".

The overall plan is considered necessary in this program in order to provide logic to the course and to guarantee that no important areas of science are omitted. The broad areas of our biological and physical world have been set out so as to provide a wide range of science experiences as the child progresses through the junior high school grades. Whatever activities the teacher-and-pupils finally select, there should ever be a rich variety of learnings. It is not intended that any or all of the suggested activities be undertaken. If the teachers can suggest better and more profitable activities than those proposed, they should by all means incorporate them into the unit in hand. It is contrary to the spirit of this course to apply a "coverage" principle in working with the unit studies.

> "Actual participation in a program of meaningful activities makes the learning experience interesting and productive of accomplishment in a way that mere book study can never do."

Number of Units to be Covered in a Year:

It is impossible to state how many units of experience are to be undertaken each year because of the many variables referred to previously. The overall plan (chart page 31) is designed on the basis of a unit of study per month or six weeks, but this time period is not to be considered as a rigid requirement. Different teachers will spend different amounts of time on the study of a particular unit. The amount of time distributed among the various possible activities will vary everywhere. Although the total number of units completed will vary from school to school it is felt that at least four units should be completed in one year by any class or group.

Regardless of the number of units completed the teacher must recognize that throughout the scope and sequence organization there should develop a common core of general understandings, abilities, skills, and appreciations that constitute essential knowledge for all students. These common learnings will not be uniform from child to child, but their acquisition will become a significant part of their living as citizens of Alberta and Canada.

Traditional Content of General Science Programs:

The overall pattern does not ignore important content in science. It is felt that students will in many instances make reference to more content

than in the past, as they proceed with their unit studies. THE "OLD" SCIENCE CONTENT IS NOT OVERLOOKED -- IT IS MERELY SET OUT IN A NEW PATTERN AND HANDLED BY A NEW TECHNIQUE. The various units do not deal specifically with the traditional topics of Air, Water, Soil, Heat, Light, Sound, Electricity and Magnetism, Weather, Machines, The Solar System, Work and Energy. A careful examination of the outlines of the units will reveal that apart from Light and Sound (these two studies are reserved for Grade X General Science), the student will have ample opportunity to experience work in the traditional areas listed above.

Pattern of Units:

Every endeavor has been made to keep the pattern of the unit as simple as possible. A unit of study is a job to be done. It involves an area of science study (title), a purpose (goal), arousing interest (approach or motivation), starting the job, working at the job, getting the job done, and summing it up or appraising the job. This is simple terminology that anyone can understand but it really explains what the unit method is all about.

The general pattern of the unit studies is shown below:

NUMBER OF UNIT and TITLE OF UNIT

Purpose of the Unit: Why do the job anyway?

Approach to the Unit: How can we get interested in the unit?

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
A list of suggestions, not prescriptions.	A small number of general concepts.

In the outlines of the units no detailed reference has been made to the general or specific objectives to be attained nor how to close off the unit (often referred to as the culmination). Nor does the program suggest any specific evaluation techniques or devices in relation to each of the units. The evaluation phase of the unit is a teacher-class affair. Reference to evaluation of units is taken up later in this manual.

The reference materials to assist in the working out of the units have been consolidated on pages 87 to 100, rather than including them under each unit outline. Note also that no specific reference to visual aids in the form of films and film strips has been included in the unit study outlines.

The Outlines of Unit Studies in the Junior High School Science Program:

In order to assist teachers to organize the unit studies the twenty-one units of the Junior High School Science program have been outlined for each of Grades VII-VIII-IX. These expanded outlines may be used as ready reference material for the teacher and follow exactly the scope and sequence found in the overall chart on page 31. The numbering of the units is for reference purposes. For example, Unit IX-6 represents a unit from the overall chart in Grade IX of the sequence and deals with the sixth area of the scope.

GRADE VII UNIT STUDY OUTLINES

Unit VII-1: ANIMALS - A BRIEF STUDY AND SIMPLE CLASSIFICATION

Purpose of This Unit: To assist pupils to learn the scientific way of naming and classifying animals. To have students realize the past and present improvement in specialization of animals as they have adjusted and continue to adjust to their environment.

Suggested Approach: A class discussion on the wild duck (or any other suitable animal) according to the following pattern:

A: Habitat
B: Special body structure in relation to
  1. Breathing
  2. Feeding and Growth
  3. Reproduction
  4. Defense
C: Summary of general adjustment to environment.

Note: This general pattern may be followed in studying each of the main broad divisions of animal life.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
A teacher-led discussion to show that animals differ from plants mainly in methods of locomotion, methods of feeding, food absorption rather than food-making, quickness of reaction in defense, etc.	Animals differ from plants.
Make a simple frieze to show pictorially or with sketches pre-historic birds and animals that have become extinct Imagine a trip to a zoo and discuss how the various animals show special skills in feeding. Make a chart of animals typical of various regions, such as mountains, forests, marshes, plains, desert, tundra, jungle, grassland. (Habitats on a regional scale.)	There is a gradual scale of improved specialization or body structure among animals.
Divide the class into groups and have a contest to discover who can come nearest to a complete alphabet of animals from A to Z inclusive.	Animal groups possess definite characteristics which form the basis for a system of classification of all animals.

The teacher will direct a full-class discussion in which pupils suggest the names of many animals. The teacher will arrange the names into two main divisions but will not at this point give any attention to details. He should, however, suggest some sort of sequence depending on the generally observed build of the animal. The blackboard should be used to record the names and the teacher should have in mind an orderly plan. Finally with colored chalk a few main headings may be set down to group them. For example:

Non-backboners (Invertebrates)	Backboners (Vertebrates)
Worms	Fish
Shelled animals	Double-life animals
Spiders	Reptiles
Insects	Birds
	Mammals

If other types are suggested, they may be included.

Animals may be divided into a number of convenient broad divisions based upon framework or structure.

Divide the class into groups (if numbers are small, adapt organization to local conditions) and assign topics for study and report. In each report consider such features as habitat, structure, life-cycle, defenses, feeding, and specialization which helps adjustment to habitat.

(a) One-celled: Try to find paramecium in pond scum or aquarium sludge or water, using a microscope or magnifying glass.

(b) Pore structured: Read to find out all about the sponge.

(c) Hollow-gut: A committee to read and report on corals and jelly-fish

(d) Worms (Segmented): Report and diagram study on the common earthworm, and if desired, the tapeworm

(e) Soft-bodied animals in shells: A class study of snails. Book reading on clams and oysters (Molluscs and crustaceans) Read also about limestone and chalk formations (Exshaw, etc) and relate to animal shells.

(f) Hard-bodied animals in shells: Diagram and sketch studies (or actual studies) of of lobster and crab; report on anatomy; report also on methods of "fishing".

(g) Spiders and Insects: Group reading and report with diagram studies on structure and "nervous system" of insects. Refer to blood color and temperature.

List differences between spider and insects.

Write two short paragraphs on the life-history and control of the following insects: grasshopper, wheat-stem saw-fly, aphid, cutworm, clothes moth, etc.

At this point plan resume material for the scrap-book under the heading "Invertebrate Animals". Use pictures, diagrams, or sketches and label them clearly.

(Reorganize the class committees at this point and proceed with the second main part of the unit which deals with Vertebrates).

(A certain amount of reasonable dissection of animals listed beyond this point may be permitted. The class might even like to visit a packing plant.)

(h) Fishes (cold-blooded): Continued reading, reporting, and scrap-book work on the fish (anatomy, habits, etc.) Try to bring fish in class and dissect it.

(i) Double-lifed animals (amphibians): Have children bring spawn or tadpoles to class and observe developments. Have one student find out differences between toads and frogs.

(j) Reptiles: Paragraph writing on: "Reptiles Then and Now". Collect pictures for the scrapbook of reptiles of long ago, local reptiles, reptiles of other lands.
Report on kinds of snakes in Alberta; their method of locomotion, shedding skin, and life habits.

(k) Birds (warm-blooded): A committee to organize a special report on birds. A general diagram carefully labelled (fore-feet replaced by wings, hollow bones, etc.)

Make a chart to show how different

birds have different feet and bills to suit their habitat (swimmers, divers, waders, scratchers, snatchers, perchers).

A map study of the Americas to show migration routes of birds passing through Alberta; the "mystery" of migration.

Prepare a list of the birds common to Alberta (organize if desired as under "habitat" above).

(l) Mammals: Read to find out the characteristics of all mammals.

Make a list or gather scrap-book pictures of mammals of the world.

Make a map of Canada and show the locations of mammals in relation to tundra-land, conifer-land, prairie-land, mountain-land.

Have a spelling-match using the names of world mammals.

Select a few mammals and discuss their special adaptations: kangaroo, elephant, giraffe, cat, beaver, etc.

Have one student arrange a section of the scrapbook under three divisions: Water-mammals, land-mammals, air-mammals.

Write a paragraph on Alberta rodents (include rat menace).

Now complete plans for a resume section of the scrapbook under the heading of "Vertebrates".

Make sketch comparisons to show how man has used the "design" structure of insects, fish, and birds in planning modern transportation machines on land, sea, and in the air (e.g. jet propulsion from the squid, streamlining from fish, wing-structure from birds and insects).

List harmful and beneficial birds and insects.

Discuss the value of all mammals to man (clothing, work, food). Emphasize fur-bearers of Canada.

All animals are important to man.

Unit VII-2: LIVING THINGS ARE ADAPTED TO THEIR ENVIRONMENT FOR PROTECTION AND FOOD-SEEKING

Purpose of This Unit: To have the student learn that adjustments are made by all living things to help them obtain food and to protect themselves in one way or another.

Suggested Approach: Using a rabbit and a well-known plant show how both are well adapted to obtain food and to protect themselves in various ways

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
With class discussion, teacher makes a board outline of examples of plants and animals that use color as a protective device The trick of "Freezing" by animals should be noted. List 10 examples of animals and 10 of birds which escape capture by speed List as many animals as possible (in say 5 minutes) which protect themselves by teeth and claws. Have a committee prepare a report on other distinctive forms of protection, e g. skunk (odor), porcupine (quills), gopher (burrows), grebe (diving), bee (sting), etc. Have another committee gather information on how plants protect themselves from animals Write a paragraph on how a duck (e g) misleads its enemies (broken-wing technique) Teacher outlines how mimicry is used in nature	Living Things adapt themselves for protection against other living things.
Divide the class into 3 groups and have each group prepare a chart showing how the teeth, lips or bill, tongue, etc. have been modified to obtain the food they require (Animals, birds, insects.) Have each student write an essay on special modifications of the feet of animals, birds, or insects, which aid them in obtaining their food. Teacher outlines, with help of class, various other body modifications to aid in securing food. (torpedo shape of fish, slender	Plants and animals are specially adapted to obtain the food they require.

body of weasel to enter burrows.) Assigned reading on special adaptations of roots, leaves, and stems of plants, which aid the plant in securing sunlight, water, and CO_2. Follow-up with short-answer Test. If interest and time permits, give report on insect-eating plants.	
A directed reading assignment to obtain information on: How animals protect themselves against cold; how plants adjust to seasonal changes; the life cycle of insects, etc. The whole unit might be summarized with a scrap-board display. Teacher to prepare an extensive test on the three parts of this unit. Diagrams might be expected.	Living things adapt to adverse physical conditions.

Unit VII-3: BEYOND OUR SOLAR SYSTEM

Purpose of This Unit: To develop an interest in and an appreciation of the "vastness" of the universe.

Suggested Approach: Read to find out what early people thought of the stars and the heavens and how they made use of stars to find their way.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Have a class discussion on early strange theories about the heavens. Follow on with a discussion of modern theories (Ptolemaic, Copernican)	Man's idea of truth about the universe changes.
Contrast modern and early ideas about stars	Stars are suns and suns are stars.
Have class observe the sky to see how many different colored stars they can find. Heat a soft iron wire to white heat in bunsen burner. Remove and watch color changes. Relate to star colors in the sky. Read to find out about the different sizes of stars in space. Find out the names of the brightest and of the largest stars we can see.	The universe is made up of many thousands of different kinds of heavenly bodies.
Observe the stars to see how many familiar "objects" you can recognize in bright star groups that are close together. Pupils to use their own imagination. Select several star groups (constellations) and have pupils report on their legends. This is a good opportunity for committee work. Working from a sky chart have students actually locate four or five main constellations in the sky. Make a sky map showing only these constellations. Discuss the reason why all groups of stars cannot be seen at the same time (seasonal constellations, southern stars). Write a paragraph on the importance of the North Star in finding direction and as a "pivot point" of the earth's rotation. Learn how to locate Polaris in reference to the constellation of the "Big Bear".	Some stars are grouped into constellations.

Try to estimate how many stars you can see with the unaided eye on a very clear night. Read about people who first invented and used telescopes. Brahe, Kepler, Galileo, Newton. Find out where some of the large telescopes of the world are located. (Canada, United States, elsewhere.) Get articles from magazines and newspapers on any of these telescopes and report to the class.	No one knows how many stars there are so man constantly seeks for more and new information about the universe.
Have teacher explain the speed at which light travels. Have class calculate the distance light will travel in a year (light-year). Look up distances, in "light-years", of some famous stars and make intelligent comparisons with concrete ideas on a time and distance scale that children can understand.	Star distances are examples of the "vastness" of space.

Unit VII-4: STORY OF THE EARTH'S FORMATION

Purpose of This Unit: To acquaint the student with suggested theories which attempt to explain the earth's beginning and to allow them to come to their own conclusions in the light of the facts as we now know them.

Suggested Approach: The teacher should explain that the "Theory of the Earth's Beginning" is an excellent example of the Scientific Method in action. It involves a definition of a problem, gathering facts, making suggestions (hypotheses), testing data, making observations and inferences, arriving at tentative conclusions, reserving final judgment until more facts are obtained.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Group readings and reports to evaluate various theories proposed over the years to explain the earth's origin (early Greek theories, La Place's theory in 1796, Collision theory, Nebular theory, Explosion theory, Tidal theory, Cloud and Dust theory). Sketch work on a frieze to illustrate the various theories.	Man's proposed theories change in the light of newly discovered facts.
Discover information on how the earth's atmosphere appeared. Discuss how man has explored the upper atmosphere. Study the composition of our air blanket and experiment to make and test for oxygen, carbon-dioxide.	An air blanket surrounds the earth.
Examine a globe and estimate the proportion of land and water on the earth's surface. Pay particular attention to polar areas. Experiment to show that water seeks its own level. Read to find out the differences in levels at each end of the Panama Canal, the Suez Canal. Have reports on such terms as: sea-level, continental divide, isthmus, estuary, straits; as pertinent to our earth's present state. Discover on a world map important examples of each.	The earth's surface is mostly water.

Reading and investigation to discover how man has attempted to divide the earth's history into long eras of time. (Try to avoid difficult geological terminology). Relate the story of the forms to the story of these time eras. Read and report on the story of the Grand Canyon. Have a special committee report on Dinosaur Days in the Red Deer River Valley.	The earth is very old in terms of our units of time.
Assigned reading on the three types of rocks found in the earth and a discussion of how they were formed. Make museum collections of local rocks and add rocks from other vicinities if possible. Have committees prepare diagram reports on "volcanoes", "geysers", "hot springs". Write an essay on the "Great Glacial Age in North America" and relate to present day glaciers. Perform a "settling" experiment by using silt, sand, clay, gravel, shells, and relate to layer formations in the earth's crust. After reviewing the way in which limestone was formed, experiment to produce CO_2 (test with limewater). (Trace back the limestone in a tea-kettle to its first source.) Note: Oil and Coal formations may be introduced briefly here if time permits. Detailed treatment will be given to these topics in the Conservation study in Grade IX.	The solid part of the earth is made up of different kinds of rock.

Unit VII-5: IDENTIFYING SIMPLE MACHINES

Purpose of This Unit: To have students develop an appreciation of man's inventive genius in the past and to recognize uses of simple machines in the immediate environment.

Suggested Approach: A class discussion to show historically how man has ever tried to overcome the force of gravity. References to problems encountered in building the pyramids, or other large works of antiquity. Contrasts with modern weight-moving will no doubt arise.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Discuss examples of work done by students during a normal day introducing as many examples of simple machines as possible. Stress the idea of movement and that work is not necessarily useful. Stress the idea that man has always tried to make his work easier. Have students hold books, then lift books or other objects a certain distance, and so develop the idea of the foot-pound as a unit of work. In climbing stairs estimate work done by students in lifting themselves.	Work must involve exerting a force over a distance.
Discuss examples of each of the six types of machines, showing how a particularly useful type of work would be difficult or impossible without the aid of a simple machine. Develop careful scrapbook material to aid in the recognition of each machine; label parts carefully and stress the fact that machines have relatively few parts.	Simple machines are devices that make man's work easier

The activities and general learnings outlined below refer to the first class lever. Follow a similar type of procedure for the other types of machines, using models. Wherever possible try to introduce practical demonstrations of these machines moving heavy weights. E.g. block and tackle lifting a weight of 300 to 500 pounds.

Assemble a model of the first class lever using a yardstick, selected weights, and spring balance. The force would be exerted by hand.	Levers (and all machines) require a "push", or force, to make them work.

Discuss examples of force being exerted by animals, power machinery, or other sources. (e.g. lifting baled hay and tightening wire fences.)

In dealing with the first class lever, vary the lengths of force and weight arms to show that the force may be less than, equal to, or greater than, the weight.

In the first class lever experiment, show that when the "weight-force" ratio is 2:1, the distance the weight rises is half the distance the force moves.

Note: -

Teachers must be careful to go no further in mathematical calculations than the simple ratios of force and weight. (e.g. 1:2; 1:1; 2:1; 4:1) Avoid development of a specific mechanical advantage formula for each machine.

A machine is used to gain some advantage.

The teacher should explain the terms friction, weight (gravity), and inertia, and illustrate their presence in the experiments on the machines.

Investigate the question of: (1) types of friction such as roller and sliding. (2) the principle of roller or ball bearing. (3) use of lubricants to overcome friction.

Gather scrapbook material as a group project to illustrate beneficial and harmful examples of these three resistors.

Resistors reduce the efficiency of machines.

Unit VII-6: MAGNETISM AND SOME OF ITS USES

Purpose of This Unit: To assist the child to develop general understandings about the way in which the discovery of magnetism led to a series of important inventions useful in our daily living. (All unit studies employ the scientific method but this unit lends itself well to experimenting, observing, trial and error, making guesses, drawing conclusions.)

Suggested Approach: Read the story of Michael Faraday's life and give an account of his famous discoveries on magnetism. The story should lead to the development of pupil's appreciation of the work of the scientist in contributing to our modern comfort.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Read stories about "lodestone" and other permanent magnets. Find as many things as you can that a magnet will pick up. Try a great variety of things. Experiment to discover if magnetism "goes through" water. Make a magnetic boat in your trying-out process.	Only certain materials can be magnetized or are affected by magnets.
Cover a magnet with paper or glass and by using iron filings and a compass needle discover the "strong spots" and "field of force" around magnets. Using a compass and a magnet, prove the "law of polarity" of magnets. Make clear the correctness of the term "north-seeking pole" rather than "north pole". Experiment with a magnetized sewing needle and a flat piece of cork floating on water to discover problems of direction finding. Read and use the globe to discover the north and south magnetic poles and relate to the "true" poles (magnetic declination).	Like poles of magnets repel each other; unlike poles attract.
Test the broken parts of a magnetized needle for polarity. Try to imagine this process carried on indefinitely. Make a magnet by stroking pieces of soft iron and steel on a permanent magnet; how may magnetism be destroyed (3 ways)?	Magnets are thought to be made up of small "molecular" magnets.

Using a compass or iron filings show that a straight wire carrying current is "magnetic". Discover the effect when (a) the wire is coiled around a pencil. (b) around a soft piece of iron. Make a simple "U" type of electromagnet and use it on a model of a lifting-crane. Experiment with the effect of different strengths of current on an electromagnet. Test the polarity of the simple electro-magnets you have made; try changing current direction.	Electricity and magnetism are closely related.
Write a paragraph on "The Advantages of Electromagnets over Permanent Magnets" (ease of controlling strength, of shutting off magnetism instantaneously, etc.) Set up a circuit (cell, push-button or switch, electric bell) to discover how and why the bell works. Draw a carefully labelled diagram of the electric bell to explain how the armature works. Make a simple home-made telegraph set and "key" to show how the armature works. Learn to spell your name in the Morse code. Examine doorbells, motors in electric fans, in washing machines, etc. to locate electro-magnets. Write an essay to show that people live differently now that electromagnets have been discovered (less door knocking, clock-winding, etc.).	Because of our ability to control electromagnets, man uses them for many of his conveniences.

Unit VII-7: HEALTH SCIENCE THROUGH THE AGES

Purpose of This Unit: To have students look backward and forward in time and place at the progress of medical or health science and to try to appreciate the contribution of individual scientists and of health heroes to our present and future healthful living.

Suggested Approach: Collect current newspaper items or magazine articles to show how modern science serves health in our present living.

.....

(Note: This unit is mainly a reading, writing, and talking unit centering around a chronological investigation of health science.)

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Reading and reporting on the ideas of the causes of disease held by primitive people. Short stories about the medicine man of ancient times, and his tribal "hang-outs" today.	Early beginnings in health healing were unscientific.
Find out why Hippocrates, the Greek, is called the first health scientist, and also the father of modern medicine. Have a doctor visit the school and talk about "Medicine With and Without Science". Ask him about the Hippocratic Oath. Have a committee read and tell about the first medical schools and hospitals (Middle Ages).	The scientific method as applied to health discoveries developed slowly.
Have the teacher tell some interesting short stories about Galileo, Copernicus, and Roger Bacon (true scientists). Floor talks by individual students on Vesalius the Anatomist, Harvey the discoverer of Blood Circulation, Blood-letting, Barber Surgeons. (some of these).	The rise of scientific inquiry and research speeded up the progress of health science.
A committee of two students to investigate and report on Anton Van Leeuwenhoek's trials and final success in inventing the microscope to help in the battle against disease. A short report on Priestley's discovery of oxygen. Put major stress on the medical importance of oxygen today.	The non-medical scientist contributes to the progress of medical science.

Write a paragraph on Fahrenheit's invention of the 212 degree thermometer.

Find out how the doctor's clinical thermometer works and show that it is really a portion of a full Fahrenheit thermometer.

A short floor-talk on Laennec's invention of the stethoscope.

Arrange the class into committee groups and prepare investigation reports on some of the following: (a) Medieval plagues like England's Black Death, or the London Plague. Could this happen in Alberta today? In jungle Africa today? (b) Benjamin Franklin's discovery of bi-focal spectacles. (c) Edward Jenner's biography. (d) Louis Pasteur's discovery that diseases were caused by micro-organisms. (e) Koch's work on the tubercle bacillus. (f) Lord Lister's work on antiseptics. (g) Walter Reed and Yellow Fever. (h) Major Walter Gorgas conquers the little mosquito. (i) Sir James Simpson discovers chloroform. (j) Florence Nightingale and Nursing. (k) Roentgen discovers X-rays. (l) Marie Curie and radium. (m) Schick and Diphtheria Tests. (n) Banting the Canadian co-discoverer of insulin. (o) Alexander Fleming gives us penicillin, etc.

Find out what scientific equipment a modern doctor uses in clinics and hospitals.

What scientific attitude should we have toward patent medicines? Cure-alls sold at fairs?

The class to write an essay on either "The Discovery of the Germ Theory of Disease, a Scientific Achievement", or "A Modern Hospital Needs the Scientist".

Try to gather pictures for the bulletin board of famous physicians, surgeons, health scientists, of hospitals.

A debate: "Resolved: That Medicine has done more good for man than any other science."

Find our about Henri Dunant and the work of the Red Cross in Peace and War. (Science saves lives in battle).

Find out what scientific health research workgoes on in our provincial, national, and world departments of health.

In modern times, science has become the "Handmaiden" of health.

(Note: This unit may be summed up by means of a "Time Line of the Progress of Health Science Through the Ages." Use the following large blocks of time: Primitive Times, The Grecian Period, The Middle Ages, The Renaissance, Modern Times, The Future.)

GRADE VIII UNIT STUDY OUTLINES

Unit VIII-1: PLANTS - A BRIEF STUDY AND CLASSIFICATION

Purpose of This Unit: To develop in students an awareness of their plant environment, an appreciation of their dependence upon plants, and the ability to recognize plant differences.

Suggested Approach: Discuss how prehistoric, ancient, and modern man has been dependent upon plants for food, clothing, or shelter. Have students bring pictures of many different plants and let them try to name them and to describe their habitats.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
The class by discussion and reference to books will discover the three main plant processes or functions (a) Photosynthesis or "light-building" for the purpose of food-making (treated simply); (b) Reproduction by cell-division or breaking up (non-sexual or asexual), and by combining of two unlike cells (sexual union of sperm or seed and ovule or egg); (c) Respiration or breathing.	There are different processes going on in the bodies of plants.
Have students list familiar plants, parts of which are used for food by animals and people. Using this list make a chart, dividing it into sections to show plant foods that come from stems, leaves, roots, seeds, flower. Have students give opinions on this classification scheme. Is it sufficiently inclusive? Have pupils write a short science article on "Plants, the Supporters of all Life."	The main difference between most plants and animals is that plants manufacture food from basic materials.
Appoint a committee to classify leaves on the basis of shape (structure). Have a committee report on all the seed plants they know (reproduction). Have a committee list all plants found around and in a slough (habitat). Make a chart of plants classified according to length of life (annuals, etc.). A teacher-led discussion of the scientific classification of the world's plants. Investigation by a committee of each of the following broad division of plants: 1. Simple-bodied plants: Microscopic or magnifying glass studies of:	Plants may be classified into a few broad divisions according to their similarities and differences.

(a) Pond Scum with comments on cells, reproduction method, habitat, and lack of a "food-distribution-pipe-line-system" (no vascular or vessel-system).
(b) Fungi: Careful examination where possible of bacteria, lichens, molds like penicillin or bread mold, mushrooms, to discover that this group possesses no plant coloring (chlorophyll) and that they reproduce asexually and sexually, that they have no vascular system, and are found mostly in water.

2. Moss group of plants: Read and study to find out about mosses and liverworts (live on land, no vascular system, asexual and sexual, etc.).
3. Fern Plants: Collect pictures or make sketches of ferns, club mosses and horsetail. Have a separate committee tell about their characteristics (mostly land, asexual and sexual, first really big pre-historic plants formed coal, underground roots, stems, and leaves, appearance of a food distribution system).
4. Seed Plants:
   (a) Naked seed-plants (non-flowering)
   Have pupils gather museum collection of cones (pines, firs, spruces).
   Have a committee discuss the characteristics of evergreens and sum up their economic value.
   (b) Enclosed-seed plants (flowering)
   Make a seed collection in vials, suitably mounted.
   Prepare a diagram of the parts of a rose.
   Make a seed-dispersal chart (hurlers, sailors, shakers, etc.), after a committee has discussed the various methods.
   Teacher to conduct seed tests for starch and fat.
   Plan an excursion and divide the class into five groups to collect and mount samples of each of the following five seed plant families - Grass, Rose, Pea, Mustard, Thistle.
   Write an essay on value of the grass family to Albertans in village, town, and city.

Unit VIII-2: LIVING THINGS MAKE USE OF OTHER LIVING THINGS (INTERDEPENDENCE).

Purpose of This Unit: To make the student aware of the struggle to obtain a balance in nature and to clarify the idea of interdependence.

Suggested Approach: Trace out a food cycle from plant, through animal, back to soil and into plant again. Use suitable local example.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Assign definite reading for a pre-view understanding of the whole unit. (Discovering Our World, Bk. 2, pp. 11-41; Science Problems, Bk. 1, Unit 11; Basic Science Series - "Balance in Nature".) Have each student list a number of "food chains" followed by oral discussion and critical comments. Divide the class into three groups and have them report on: (1) Plant and Animal Struggle (Animals eat Plants; Bacteria eat Animals); (2) Animal versus Animal (Use each other for food); (3) Plant versus Plant (Saprophytes). Write an essay on "How Weather Changes Limit Plant and Animal Numbers". (Penguins have no diseases but ---)	A constant struggle exists to achieve a food balance in nature.
Have five groups prepare reports on: (1) Plant and Animal Partnership (bees and flowers, etc); (2) Animal and Animal Partnership (ant and aphid, etc); (3) Plant and Plant Partnership (lichens as a green algae and fungus); (4) Plant and Non-Life Partnership (composition of air, water cycle, nitrogen cycle, etc); (5) Animal and Non-Life Partnership (maintaining composition of air, water cycle, nitrogenous foods). Make an aquarium as a class project and maintain it in healthy condition (e.g. murky water is a sign of too many plants, etc).	Cooperation exists to achieve a balance in nature.
With class help, the teacher develops a blackboard outline of the many ways in which man upsets the balance of nature (breaking	The balance of nature can be disturbed.

land, draining swamps, killing certain animals, introducing new types of plants and animals, D.D.T., 2-4-D., etc).

Have individual students report on the following problems created by congestion of human population, e.g. lice, mice, rats, cockroaches, bed-bugs, fleas on rats (bubonic plague), polluted waters, etc.

Note: A very good summary of the unit could be made by building up and discussing a "Chart of Inter-relationships" Ref. Science Problems - Bk. 1, p. 385, or Wonderland of Science - Bk. 7, p. 297.

Unit VIII-3: WITHIN OUR SOLAR SYSTEM

Purpose of This Unit: To develop an understanding of the earth's place in the sun's family.

Suggested Approach: Begin a class scrapbook of pictures and articles on the sun, planets, comets, and meteors.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Have the class read and report on information about the sun. Make a carefully directed assignment. After discussion, summarize the main characteristics of the sun. In order to understand the meaning of sun's temperature, experiment to show how Centigrade and Fahrenheit thermometers are graduated. (Use diagrams carefully).	The sun is a very large, hot body.
Assign committee work to investigate different theories about the "birth" of planets. Make a wall chart showing relative sizes and distances of planets.	Man proposes different theories to try to explain the origin of the planets. (Others may follow.)
Organize committee work to find out information about each of the planets, the planetoids. Readings and discussions about famous meteors (shooting stars) that have "hit" our earth. Write an essay on an "Imaginary Trip to the Moon". A teacher-led discussion and presentation on moon phases. A simple explanation of tides with diagrams and pictures.	The revolving members of the Solar Family are all different.
Read about comets and write a short science article about them in your notebook. Draw a diagram of the Solar Family showing a comet's path.	"Visitors" come to our Solar Family now and again.

Unit VIII-4: THE EARTH'S "COVER": WEATHER AND EROSION

Purpose of This Unit: To have the pupils experience activities in relation to the earth's crust, so that they will have a better understanding of weather, soils, and erosion.

Suggested Approach: A directed reading assignment to discover why soil is so important to most forms of land life. Discuss such topics as: Above and below the timber line on mountains, soil-less agriculture, mosses and lichens, need of water, heat, and chemicals in soil.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Have a group trace the origin of soil from igneous rocks to loam. Make a chart of the stages. Class discuss and make a summary of the different ways rocks are broken down by the forces of nature. Prepare charts to show the effect of nature's forces in soil-making. Experiment to show the effect of heat on matter (expansion and contraction). Experiment to show the expansive force of freezing water. Gather pictures to show the effects of nature's forces on rocks and soil and mount them on a scrap-board.	Many forces combine to make soil.
Make a collection of different kinds of soil found in your district. Mount them and label them clearly. Experiment to show how loam contains organic material. Experiment with different types of soil to show (1) weight per unit volume, (2) amount of water each type will hold, (3) relative time required for water to soak through each type. Clarify the terms "light" and "heavy" soils. Experiment to show capillarity and relate to water travelling upward in soil.	There are many types of soil.
Experiment to show that heated air rises (convection). Read and draw a chart to show water movement from large bodies of water to the air, and then to the soil. (water cycle).	Most soil moisture comes from the air.

Make a study of the hygrometer.
Experiment to show how the amount of moisture in the air can be measured.
Group reading and report on the following: evaporation, saturation, dew-point, cloud formations, fog, and types of precipitation.

Experiment to show that air exerts pressure.
Experiment to show how a mercury barometer is constructed.
Read Torricelli's experiments with the barometer to discover how he used it to show that it could be used to measure altitude.
Change a sea-level barometer reading from centimetres to inches of mercury.
Try to find the normal barometer reading in your community.
Group report on the aneroid barometer and its advantages.
Teacher to lead a class discussion on high and low pressure areas. Use simple map diagrams. (Lamp chimney experiment).
Read and write paragraphs on cyclones, tornadoes, and water-spouts.
Draw a Mercator map of the wind systems of the world. Include global diagram work.
Write reports on "Land and Sea Breezes" and "Monsoons".

Temperature and pressure variations of our air cause weather changes.

Make a list of the chief instruments used at a weather station. (Students might give individual reports.)
Set up your own weather station and keep records. (Make an anemometer and rain gauge; set out a thermometer and barometer.)
If possible visit a weather station.
Read and discuss in class "fronts" as used in weather forecasting.
In a paragraph carefully tell the difference between weather and climate.
Write a directed essay on "Man's Dependence on Weather Forecasting" or "The Weatherman at Work".
Further suggested topics: Alberta's Chinooks, Sun Dogs, Red Sky at Night, Ring Around the Moon, Canada's Meteorological Service, Weather Folklore and Weather Jingles.

Man uses his knowledge of science to forecast the weather.

Unit VIII-5: ENERGY AND ITS USES

Purpose of This Unit: To develop an understanding of the different forms of energy and how man has transformed energy to bring it under control.

Suggested Approach: A bulletin board collection of clippings which illustrates interesting forms of energy common in Alberta. The teacher should develop from these materials a definition of the word "energy", relating the term to work or motion.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Class readings to discover current views on molecular structure of matter. Discussion should be led by the teacher. Divide the class into groups and have the group leaders report on each of the following forms of energy, giving clear examples of each: (a) Heat (molecular motion) (b) Radiant (heat, light, radio, cosmic waves in space) (c) Chemical: (i) organic or vital (ii) inorganic (d) Mechanical (water wheel, windmill, mainspring of a watch, a baseball in motion, elasticity) (e) Magnetic (see Wood & Carpenter: "Our Environment, How We Use and Control It" - p. 294) (f) Electrical (and relation to magnetic energy) (g) Atomic (based on arrangement and number of neutrons, protons, and electrons; the teacher should avoid any involved study).	There are several forms of energy.
Conduct a diagram report on a hot-air or a hot-water furnace system, to show how chemical energy of gas or coal is changed to radiant energy in a room of a house. Trace the changes in energy forms from the dammed water at Seebe, Alta., to an electric toaster or range in an Edmonton home. Trace the energy of a Diesel locomotive back to the radiant energy of the sun. Trace the heat and mechanical energy in our bodies to the food we eat.	Energy can be changed but cannot be created or destroyed.

Heat some ice and note what happens as it changes from solid to vapor. Observe especially the melting and boiling temperatures.	There are three forms of matter.
Try to find a way to measure the boiling point of water at reduced and at increased pressures. (Expt.: See Lynde: Science Experiences With Inexpensive Equipment, p.79) Discuss how these principles are used in the process of making condensed milk, boiling eggs in mountain areas, cooking in high altitude planes, evaporation of brine, pressure cookers.	Boiling point and freezing point depend on pressure and temperature.
A brief explanation by the teacher of elements, compounds, mixtures, and solutions. (Use sugar, water, sand.) Perform experiments on contraction and expansion of the three forms of matter. Introduce the idea of conduction at this point. Perform experiments on evaporation, distillation, condensation, and show their relationship to weather phenomena (rain, clouds, hail, dew, humidity, man-made rain using dry ice). Experiments to show the physical change called convection. Perform experiments to demonstrate slow and rapid oxidation, (iron rusting, silver tarnishing, a burning candle, a Bunsen burner, burning magnesium ribbon as examples of chemical combination). What is meant by kindling temperature? Discuss how man speeds up and slows down oxidation for specific purposes (coal stove with a good draught versus a bridge coated with paint). Heat sugar or salt in an old spoon (examples of chemical decomposition).	Energy is required to bring about physical and chemical change.
Student reporting on famous men who have contributed to the development of uses of forms of energy. E.g. Watt (steam), Franklin (electrical), Newton (mechanical), Edison (light), Joule (heat), Lavoisier (chemical). etc. Scientists "stand on the shoulders of their predecessors". Make maps showing locations of possible energy sources in Alberta (coal, oil, gas, timber, water power, tar sands). Teacher should stress "Resource Conservation" idea.	There are several undeveloped sources of energy in our province and elsewhere.

Under teacher direction read about such possible future sources of energy as: solar energy, tides, volcanoes, and geysers, and undeveloped uses of atomic power. (Students might like to make creative cartoons on this subject.)

Students to write a short essay on: "The Energy of Our Future World", or "Energy Developments Today and Five Hundred Years Ago."

Unit VIII-6: THE PRODUCTION OF ELECTRICITY, AND ITS DISTRIBUTION IN THE HOME

Purpose of This Unit: The purpose of this unit is to learn how electricity can be produced and how we make use of it and control it in our homes in order to make our living more pleasant

Suggested Approach: The teacher may direct the building up of a blackboard chart. Sketch a house in miniature in the centre and label it "A Modern Electrified Home". From four directions (upper right, upper left, lower right, and lower left) draw four radial lines labelled thus: (1) Alberta Power, (2) Town Power from Coal, (3) Rural Power from Wind-chargers, (4) Future Atomic Power. Discussions might in every case start with Solar "Power", e.g. (a) Sun, Clouds, Rain, Rivers, Dams, Water-wheels, Electricity for the home; (b) Sun, Plants, Animals, Coal, Steam, Engines, Electricity for the home. Atomic Power calls for no detailed discussion; in fact a large question-mark might be sufficient.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Make a cell to show that electricity can be made from chemicals. A simple cell can be made by pushing strips of copper and zinc into a lemon and then connecting the strips to a current meter. (No explanation of chemical action). Take an old dry cell or flashlight battery apart to see how it is made. Make a labelled diagram assuming that you sawed the cell in two from top to bottom. Perform experiments with frictional or static electricity using a comb, or a fountain pen, or rug, or a piece of fur. Read and tell the class about Franklin and his kite experiment. How can this story be connected with frictional electricity? Visit an electric power plant if you can to see how electricity is made. How is electricity produced in a farm electrical plant? Examine an old car generator to find the stationary or field magnets, and also the spinning armature. Make several turns of wire and connect the ends to a current meter. Then push a bar magnet quickly in and out of the coil.	Electricity can be produced in several ways.

Read texts to discover how water, steam, wind, and exploding gas, are used to make electricity by turning generators.	
Make a simple electric motor and tell how it works. Bring a toy motor to school and compare it with the simple one you have made.	Electricity is used to produce motion in an electric motor.
Experiment with various kinds of materials and discover if they are insulators. How many kinds of insulating materials are used in connection with your home wiring? Repair a broken electric light socket or a broken electric light plug. Learn the proper way to splice wire and make connections. Why is a frayed cord on a toaster dangerous? How dangerous?	Conductors "carry" electricity; non-conductors (insulators) do not.
Using a switch, some wire, a small flashlight bulb, and a dry cell, make an electric path or circuit. Set up a circuit which includes an electric light. Make a short circuit at a point nearest the dry cell by baring the wire. Why is a short circuit dangerous?	Electricity flows by the shortest complete path.
Bring a house fuse and a car fuse to school. Break carefully with a hammer and examine the inside. Put an electric light fuse in a circuit and make it act like a switch. Learn how to put a fuse in your switch box at home. Why won't a penny do just as well? If your car fuse burns out and you have no lights, some people have inserted a piece of lead foil from a cigarette package. Is this a good plan? Why? Why not? Examine types of switches used at home. (Toggle, snap, blade, push-button, and blade switches.) How does a car key on the dash board act like a switch?	Electric switches and fuses are devices to "break" an electrical circuit.
Break an old electric light bulb and hammer away the screw-in base to see how electricity goes through it. A labelled diagram in your notebook will tell how a light bulb is made. Experiment with Christmas tree lights to learn about lights in series and in parallel. Make a simple mural using sketches to show the history of lighting from primitive times to the present. Obtain if possible an old light meter and study the gearing and also how to read the meter. Learn how power is paid for by the consumer in kilowatt-hours. Write an essay on the "Benefits of Electricity to Modern Life".	Electricity is a great servant of man.

Unit VIII-7: MICRO-ORGANISMS: BENEFICIAL AND HARMFUL

Purpose of This Unit: To show students the inter-relationship between micro-organisms and man.

Suggested Approach: Place moist bread in a closed box in a warm place for several days. Observe the mold with a microscope or powerful magnifying glass. Read for information about what you see.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Discuss and summarize your findings about the bread mold. Include note-book diagrams and label parts carefully. Experiment with yeast culture. Place some yeast in molasses and make observations with a microscope. A directed reading assignment (with micro-scope work if possible) on the three types of bacteria followed by a class quiz. (Coccus, bacillus, spirillum.) Each student to prepare neat and carefully labelled sketches of the three types of bacteria above-mentioned.	There are a few main kinds of micro-organisms that affect man.
Have committees report on the three types of micro-organisms (molds, yeast, and bacteria) with special reference in each case to: Food, light, moisture, temperature, movement and reproduction. Prepare charts to sum up the contrasting behavior of the three types of micro-organisms.	Micro-organisms are living plants and need a special type of environment.
A teacher-led discussion on "wonder-drugs" such as penicillin, streptomycin, etc. (Teach the meaning of the word antibiotics.) A group report on the molds used to flavor cheese. Experiment: Use the yeast culture to show fermentation (production of carbon dioxide and alcohol). Test for carbon dioxide. A committee report on the production of (1) Commercial alcohol, (2) Vinegar. Discuss uses. A committee of girls to read about, and write a paragraph on, "Why Yeast is Used in Making Bread".	Micro-organisms can be a help to man.

A committee of boys to read about, and write a paragraph on, "Bacterial Action in a Septic Tank".

Make some simple cheese from sour skimmed milk by warming and separating it. Eat it.

Read about and discuss some of the following to show the part played by bacteria: (1) Tanning leather, (2) Retting flax, (3) Making cheese, (4) Restoring nitrogen to the soil.

Write a planned composition on how plants and animals return to the dust "from whence they sprung". (Bacterial action.)

A teacher-led discussion on food spoiling and bacterial poisoning (action of bacteria before and after eating).

Micro-organisms can be a hindrance to man.

Experiment: Use methylene blue dye to test for "bacterial count" of a sample of milk.

Group reports on some of the following bacterial diseases: tuberculosis, typhoid, ringworm, septic throat, athlete's foot, undulant fever.

Experiment: Show how milk is pasteurized.

If possible, plan an excursion to a modern dairy, and have a follow-up report under teacher direction.

Man preserves his food by controlling micro-organisms (bacteria).

Group reports on the various ways in which man has been able to preserve food: (1) Refrigeration, (2) Quick-freezing, (3) Use of vinegar, salt, and spices, (4) Smoking of foods, (5) Dehydration (milk, eggs, vegetables, fruit), (6) Canning.

Experiment: Test water for micro-organisms using a filter, slide, and microscope.

How has science made it possible for cities to obtain pure water at the tap? (Chlorination, filtration, sedimentation, aeration).

Look up a dictionary definition of parasite and saprophyte. Do you find the words too hard to remember?

Class to write an essay on: "Cleanliness, An Enemy of Micro-Organisms."

GRADE IX UNIT STUDY OUTLINES

Unit IX-1: PLANTS AND ANIMALS BASIC TO ALBERTA'S AGRICULTURE

Purpose of This Unit: To develop an appreciation of the economic importance of plants and animals in Alberta's agriculture at the present time.

To develop some knowledge of how new strains and varieties have been introduced, and why old strains or varieties have been improved or dropped.

Suggested Approach: Teacher and pupils may read and talk about the story of primitive man and how he finally settled down after a wandering type of living, and began to cultivate grains and domesticate animals.

or, Discuss the food, clothing, and shelter problems faced by Robinson Crusoe.

SUGGESTED ACTIVITIES (Plant Studies)	MAJOR IDEAS (GENERALIZATIONS)
Make a world map of the grain-growing areas of the world. Make circle graphs showing production of wheat in the world "bread-baskets". Make similar graphs for other grains grown in Alberta.	Grains have always been a major source of man's food supply.
Investigate the basic laws of the Dominion Grain Trade (Ottawa, Dept. of Agriculture). A careful discussion of grain grades as reported in the newspaper and over the radio. Invite an elevator man to come to the school and tell how he grades grain. Write to Ottawa and obtain data on the Canadian Wheat Board and discuss its "pros" and "cons".	Our governments protect the buyer and seller by setting up control standards.
Read to find out about the early history of early wheat varieties in the west. (Red Fife, Marquis). Obtain information about new varieties of wheat and why they have been developed. Find out where winter wheat is grown in Alberta and why. (Also varieties grown.) Prepare a bar graph to show amount of wheat production in Alberta in ten-year periods since 1900.	Wheat is of major importance to Alberta's people.

Report on varieties of oats and barley and areas where best grown in Alberta. Read to find out reasons for growing barley, oats, alfalfa. Make booklets on "Irrigated Crops in Southern Alberta" and "Grain Clubs in Alberta". Carry out further graph work on the crops referred to above. Make collections in vials of grain seeds carefully mounted and labelled. A group committee to study about "Alberta Weeds and Their Control".	The raising of crops other than wheat is also important to Alberta's people.
SUGGESTED ACTIVITIES (Animals)	**MAJOR IDEAS** (GENERALIZATIONS)
Pupil-written report from a planned blackboard outline on the topic: "How Alberta Animals Feed Albertans".	Animals are a major source of human food.
A similar report in good English style on: "Uses of Alberta's Animals Apart from Food Production".	Animals provide us with clothing and other things.
If class size permits divide into groups for each of the important animal divisions. The teacher may plan with the class the areas of investigation (description of breeds, why changes in volume of animal production occur, reasons for selection of specific breeds, importance of feeding, selection of sires, markets, etc.). Excursion to live-stock centres; experts invited to talk to class. Special oral reports from members of calf and swine clubs. Collect pictures and post on scrap-board for each of the groups of animals. The following is a suggested list of animals: (1) Poultry, (2) Fur Farming, (3) Sheep, (4) Swine, (5) Cattle, (6) Horses. Write an essay on the topic "The Horse is Canned".	There are several kinds of animals important to Alberta's agricultural economy.
The teacher should now take over and direct an economic summary aided by blackboard outlines, statistics and graphs. Explore the following suggested areas: Number of animals raised, production volume of grain crops in bushels, cash value of products, changing trends in breeding, research work in development of new varieties, how markets and prices affect amount of production in our province.	Food plants and animals have a high economic value in the life of our Alberta people.

Unit IX-2: NATURAL AND ARTIFICIAL IMPROVEMENT OF ECONOMIC PLANTS AND ANIMALS

Purpose of This Unit: To show the importance of natural plant and animal selection through the ages, and to show man's application of the scientific method to improve economic plants and animals.

Suggested Approach: Brief discussion of the high standards set by Canadian wheat and bacon in the markets of the world.

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(Note: This unit lends itself well to the preparation of a well-organized scrapbook in two main sections: PLANTS, ANIMALS)

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Have students list the qualities desired by the consumer in some of the following: - wheat, potatoes, corn, peas, apples, milk, poultry, eggs, meat, etc. Read about plant diseases and insect damage in Alberta. Find out what varieties have been developed which are resistant to these enemies. Find out what special breeds of animals have been adopted in Alberta to suit conditions here. Oral reports on what has been done by man to overcome the following adverse factors affecting plants: drought, frost, low productivity, low soil fertility, and weeds. Investigate the standards used in selling canned vegetables and fruit, butter, eggs, meat, etc.	Selection of plant varieties and animal breeds by the producer is based upon consumer demand, resistance to parasites, and climatic conditions.
Have the teacher outline evidence of natural changes and selection in plants and animals through the centuries. Refer to studies made by LaMarck, Darwin, DeVries in this field. Contrast several modern domesticated animals with their ancestors. Read to find out the importance of: natural selection, mutation, and inheritance in the natural improvement of species.	Natural improvement in plants and animals has been a long and continuous process.

Class should read about the experiments performed by Gregor Mendel.

Students select their own examples from plants, animals, people of dominant and recessive characteristics. Prepare a chart to show three generations.

Investigate what is meant by hybrid plants and animals. Discuss advantages and disadvantages of hybrid forms. e.g. Mule, hybrid corn.

A class reading assignment on: "The Work of Luther Burbank".

What is meant by Mutation? List various examples. (Colchicine is now used to produce mutations in plants.)

Check the meaning of the following terms as applied to the improvement of plants and animals: grafting, budding, inbreeding, cross-breeding, grading up, dominant, recessive, chromosomes, genes.

Write an essay on the broad topic of, "Artificial Improvement of Plants or Animals"; or on a restricted topic such as, "The Development of the Boysenberry".

Scientific methods have been used to artificially improve plants and animals.

Unit IX-3: EARTH MOVEMENTS AND RELATION TO TIME TELLING

Purpose of This Unit: To develop an understanding of the basis for time telling on the earth, and to relate time telling to local happenings and news flashes from all over the world.

Suggested Approach: Discuss the Alberta time of starting a world series baseball game in New York, a hockey game in Toronto, a liner arriving in Vancouver, the bombing of Tokyo in Great War II, and a "News Flash - Jan. 1, 1960: Man Arrives in San Francisco Five Minutes Before He Left New York."

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Read to discover various ways used by man to tell time in by-gone days. (Write to American Council on Education, Washington D.C., to find out the price of a pamphlet: "Telling Time Throughout the Centuries.") Make a summary in chart or outline form of various time-telling devices from ancient to modern times. Relate the sand-glass-egg-timer to the early hour-glass. Using your imagination, discuss reasons why early man needed to tell time. Find out how to make a sun-dial and discover how it works.	Man has always needed to measure time.
Using diagrams, globes, and models discuss the various motions of the earth (rotation, revolution, "forward" motion) (day, year, seasons). Imagine the change in our seasons if the earth's axis had no tilt, a greater tilt than now exists. (Think of oil located at Fort Norman.) Interpret the statement: Centrifugal force and gravitational pull in the heavens maintain a perfect balance in our astronomical "wonder watch". Show that the ticking off by our watches of one second of time is related to the timing of the earth's rotation and revolution. Using models and globe, experiment in a darkened room to show how heavenly bodies "cut in" on the "astronomical time clock". (eclipses - lunar and solar.)	Time is measured by the earth's motions.

Make diagram studies of eclipses. Report on "leap years".	
Review circular measure (degrees only: avoid minutes and seconds for majority of students). Working with globe and world maps develop the world's layout of latitude and longitude. On a map of Canada locate and name the standard time belts. Teacher to prepare simple problems on Longitude and Time. (Time differences between your home locality and London, England; Toronto; Honolulu.) When it is noon by your watch is it "noon" by sun? Explain. Have a committee locate the International Date Line and tell the class about it. Have a 10-minute debate on the subject "Daylight Saving Time in Alberta". As a summary the teacher may illustrate how the invisible street system of the earth (lat. & long.) may be likened to the streets and avenues in a city such as Edmonton or Calgary.	The earth is divided into convenient time belts or zones.
Compare solar time at Greenwich with standard time in your locality (longitude). Indicate that latitude is not related to time but rather to place. Make a field instrument (protractor) to find the latitude of your localities from the angle of elevation of Polaris. Make use of a diagram. In the northern hemisphere the Dipper rotates around the north star like a clock. Explain. Read to discover how Boy Scouts find direction with a watch.	Time and place are inter-related.
Write to The World Calendar Association, 630 - Fifth Ave., N.Y. 20 for a free pamphlet on "The Journal of Calendar Reform". Have a committee report on the proposed reforms. How does an electric clock work? Make a poem, jingles, or limericks about "Time".	Time "marches" on.

Unit IX-4: CONSERVATION OF EARTH'S RESOURCES

Purpose of This Unit: To learn that our resources are limited and that conserving them is a personal as well as a group responsibility.

Suggested Approach: Draw a map of Alberta, carefully marking the following: forest areas, oil and gas areas, coal mines, and tar sands. Or Using the Canada Year Book find the value of Alberta's production of forest products, petroleum products, coal, and wheat for any recent year. Show these on a bar graph.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Review weathering and erosion factors. Collect pictures for the scrapbook to illustrate the results of wind and water erosion. Experiment to show how running water forms gullies and washes top soil away. Describe various methods of controlling wind erosion by cultivation and cropping (include strip farming, contour cultivation, cover crops, planting grass, tree windbreaks, etc). Committee reports on methods of preventing water erosion (include contour farming, cover crops, strip cropping, terracing, grass crops, basin listing, tree planting, etc). Write paragraphs on some of the following: "dust bowls", "farms in the sky" (dust storms) crop rotation, fertilizing, floods, flood control, irrigation, deltas. (Examples may be drawn from Alberta or elsewhere.) Prepare an outline map of Alberta, marking in the rainfall distribution by different shading.	Erosion by wind and water can be controlled.
Write a letter to Department of Lands and Forests, Edmonton, for information on government timber regulations. Make a list of some of the important uses of our Canadian lumber. Read to find out the annual loss by forest fires in Canada and suggest how these losses occurred. Discuss steps taken by the government to prevent forest fires.	Timber losses can be reduced.

Write an article on one of the following: reforestation, controlling insect pests in timber stands, protection of forests in National Parks. What happens to the following when forests are depleted: level of water table, river levels in spring, soil erosion, balance in nature, cost of home building. Write a paragraph on "The Tragedy of Christmas Tree Traffic".	
A teacher-led discussion to show that our mineral resources are limited. Refer to specific minerals like petroleum, natural gas. Make a list of the ways in which we waste our mineral resources (include gas flares, smoke from steam engines and factories, (Black Country, England), excessive automobile speed, inefficiency of engines, etc). Read to find out any possible future sources of fuel. Write a brief essay on: Resources - "Quickly Consumed but Slowly Restored".	The supply of our mineral resources can run out.
List a number of animals in Alberta's wild life and explain the value of each. Have a pupil tell about a visit to a fish hatchery and explain what is done with the fish. How do fish going up or down stream get by big dams? Prepare committee reports on the following: Buffalo parks, "No Shooting" in National Parks, Ducks Unlimited, Government Regulations regarding open and closed seasons on game, The Duck Invasion of Grain Fields.	Man is concerned about the disappearance of wild life.
A guided essay on the "Beauty of Alberta". Have a student find information on the number of tourists who yearly enter our National Parks, where they come from and the yearly revenue they bring to Canada. Discuss and list many ways in which we can be of assistance to tourists and to make their visit a happy one. Have a student report on tourist accommodation in the United States and compare it with what we provide. (Motels, etc.) Where are tourist bureaus located and of what value are they? Make an attractive scrapbook of scenes in the mountains of Alberta.	Tourist trade is a significant Alberta resource.

Write a paragraph on "Science Lengthens Man's Life."

In our Machine Age the five-day week seems near. Suggest valuable and worthwhile ways for people to relax and use their leisure time.

Man is learning how to conserve his human resources.

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Note: The teacher may select other phases of conservation not mentioned in these specific activities, e.g. Water power, Burning stubble, Water the Life-Giver, Soil the Life Supporter, The Helpful Beaver, Enemies of the Forests, Fur-Bearers, etc.

Unit IX-5: MACHINES AND THEIR SOCIAL IMPLICATIONS

Purpose of This Unit: To develop an appreciation of our machine age as well as a knowledge of some of our basic machines.

Suggested Approach: Compare and contrast modern living in our mechanized America with that found in the backward and primitive regions of Asia.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Review scientific definition of work, and energy. List a number of different forms of energy. Make a list of machines stating the form of energy each uses and what form of energy each gives out. e.g. a water turbine and generator change energy of moving water (mechanical energy) to electrical energy. Find out the meaning of friction, gravity, inertia, and tell how each affects the "ability to do work". Experiment with the three levers to show the mechanical advantage of each type. (Law of Levers). Set up various pulley combinations. Use a weight and a spring scale (balance) to find the mechanical advantage of each arrangement. Discover the mechanical advantage of the wheel and axle. Using a triangular strip of paper wound on a pencil show that the screw is an inclined plane. Experiment with inclined planes to determine the mechanical advantage of this type of machine. Show that the wedge is a double inclined plane. Examine some selected complex machine to show that it is really a combination of the six basic machines (e.g. a crane, a lawn-mower, sewing-machine, etc.)	Six simple machines help man to do his work.
Make diagrams of lift-pump, force-pump, and rotary-pump. Experiment with models to see how they work. Obtain a used rotary car water pump from a garage and show how it is constructed. Perhaps an electric motor might be used to show it pumps water. Show the difference between a water pump and an air pump.	Liquid or gas pressure is used in certain machines.

Make a list of uses of air pumps. Read how some machines operate by drawing air out, e.g. vacuum cleaner, a milking machine. Cite examples of hydraulic presses in common use. Make a diagram of a hydraulic press and show how it is able to exert force. Calculate the mechanical advantage of various presses. Study (1) the hydraulic brake system of a modern car (2) hydraulic lifts on the modern farm machinery.	
Discuss why people perspire freely on a hot day. Have pupils read in class to find out how an electric refrigerator works. Draw and label carefully a simple diagram of an electric refrigerator. Have a group tell how modern science has contributed to rapid shipment of perishable foods over the world.	Liquids require heat to change them to a gaseous state.
Read carefully to discover the meanings of the terms: foot-pound, horse-power, and kilowatt. Find out how power is calculated. Make careful diagrams or models of different types of water-wheels, showing how each works. Sketch a diagram of a hydro-power dam and plant. Using a map of Alberta, locate the developed water power sites in our province. Have a student report on his visit to a hydro-power dam. Draw a cross-section diagram of a steam engine and explain its operation. (Stress combustion OUTSIDE the engine.) Study cross-section views of what goes on in a gasoline or diesel engine. (Stress combustion INSIDE the engine.) Make a summary of points of contrast between a gasoline and a diesel engine.	"Stored-up" energy can do important work for man.
Read the story of the history of the automobile showing the application of the principle of scientific experimentation and how modern machines came from humble and crude beginnings. Class members might tell stories about the lives of Henry Ford, George Stephenson, Diesel, and others.	Science moves the wheels of progress.

Find out the advantages and disadvantages of coal or oil-burning locomotives, diesel-electric, and gas-turbine locomotives.

What part might jets or rockets play in rail travel?

Compare Stephenson's "Rocket" train with a modern locomotive.

Find out date of Stephenson's invention.

Teacher explanation of the meaning of lift, gravity, thrust, and drag as applied to airplane operation.

What is the function of the propellor of an airplane?

Boys might bring model planes and explain how they fly.

Read what precautions aviators have to take to fly at high altitudes.

Write a short story telling of a trip in a modern airliner.

Experiment with a balloon by blowing it up and releasing it so that the escaping air forces the balloon in the opposite direction.

Teacher explanation that rockets and jet engines operate on the principle that large quantities of gas escaping rapidly force the rocket or jet engine forward.

Why might rockets be used in space ships but not jets?

Students might report on the value of jets to future air travel.

Imagine a rocket trip to the moon or a nearby planet.

Sketch a map of Alberta showing areas where rainfall is insufficient to produce satisfactory crops.

Discuss ways of providing water to low-rainfall areas.

Why are pumping systems not too satisfactory? (Find out about the new rotary pumps designed to fit on a farm tractor.)

Find out about irrigation areas in Alberta and more especially about the St. Mary's Irrigation project.

What are some projected irrigation schemes in our province?

List a number of social benefits and social dangers that may result from man's use of atomic energy or power.

How will further developments in man's use of energy affect (1) man's weekly hours of work, (2) man's leisure, (3) distribution of jobs among people.

Write a short essay on "Machines, Men, and Jobs".

The world's future social and economic development may depend on man's wise control of atomic energy.

Unit IX-6: ELECTRICITY IN OUR DAILY LIVING

Purpose of This Unit: To help students realize the many ways in which electricity has transformed our modern living.

Suggested Approach: A combined picture and blackboard-summary discussion contrasting the modern home with the pioneer home of one hundred or two hundred years ago. Deal with such electrical conveniences as those advertised in catalogs, magazines, and newspapers.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
Use copper, iron, steel, and nichrome wire and note temperature differences to the flow of electricity from a dry cell. Review the factors which determine the amount of heat produced from the flow of electric current. (current strength, type of conductor, cross-sectional area of the conductor, length of conductor.) Examine an electric iron and also the thermostatic controls on it. Examine an electric toaster to show that it is a "resistance-heater". What is the principle of the "pop-up" toaster? Procure advertisement material to find out how an electric range works. Find out how block-heaters for cars are installed and explain why they are easily and safely maintained as compared with other methods of heating. How does a "thermostatically" controlled water heater in a house work? How do natural gas heaters compete with the electric types? In Alberta? Elsewhere? Why are electric fire places and radiant heaters convenient but not really economical? How do Electric Welding Machines work? Find out about some of the following: Coffee Percolators, Hair-dryers, Electric Heating Pads, Baby-bottle Heaters, Car Heaters for Outdoor Theatres, Heated Clothing for High Altitude Fliers.	The principle that electricity will flow easily along some conductors and less easily along others (resistance effect) is used in many home appliances.
Read to discover how incandescent lamps are made (hot light). Interpret the markings on electric lamps.	Electricity can be used to produce light and special rays.

Discuss various uses of incandescent lamps: Home, street, camera, cars, searchlights, floodlights.

Fluorescent and neon lighting: (cold light). Features: Low pressure, vapor, high voltage.

Direct, indirect, and concealed (or recessed) lighting in the home of today.

Ultra-violet light: Read in a health book about Sun-tan and Vitamin D; also use of such light for sterilizing medical instruments, healing wounds; possible future uses in killing germs in air-conditioning units.

Read and report on Roentgen's famous work on X-rays.

Perhaps a doctor might be invited to the school to talk on medical uses of (1) the fluoroscope screen, (2) plates for bone-investigation.

How does a shoe-fitting "ray-machine" work?

What is the method of testing materials for hidden flaws (e.g. in metals; use by customs officials).

Group discussions based on directed reading in class (or out of class) to discover that electric motors make many things work. - Vacuum cleaner, Mixmaster, Electric clipper and shavers, Lawn-mowers, Clocks, Floor-polishers, Washing machines, Dish-washers, Shop tools, Garbage-disposal grinders in the kitchen, Sewing-machines, Trolley-cars and buses, Refrigerators, Fans, etc.

Motors are run by electricity to suit our needs.

Learn how the telephone transmitter and receiver work.

Show the similarity between the telephone transmitter and (1) the radio microphone, (2) hearing aid.

Show the similarity between the telephone receiver and the radio loud-speaker.

Write an essay, or prepare a mural on the "Stories of the telephone, telegraph, cablegram, and the radio microphone".

How is the electric eye used for rapid counting? How does the "eye" open doors, work a burglar alarm, run a robot machine? (No detailed study.)

Electricity makes possible instantaneous communication.

Make a map of Alberta's electric power lines.

Find out how gasoline and diesel electric plants work (voltage usually 32V).

Make a model of a wind-charger.

Rural electrification makes farm life easier and more attractive.

How are storage batteries used in farm units?

Relate them to a wind-charger. (16 cells of 2 volts each).

The storage battery in a car consists of three units of 2 volts each. Tear down an old battery to examine the "insides".

Unit IX-7: ACCIDENTS AND FIRST AID

Purpose of This Unit: To discover the need for personal and group cooperation in helping to reduce the annual loss of life resulting from living in a highly mechanized and industrialized world.

Suggested Approach: A teacher-and-pupil discussion on "Safety First" based on the accident picture in Canada and the United States. (Write to the National Safety Council, Washington, D.C. and ask for information on Accident Facts.) Discuss such startling statements as: In the time taken to read a page of your science book, a man, woman, or child in the United States has been killed. Or: Each year in the United States there are nearly as many people injured as live in the whole of Canada. On the bulletin board, post newspaper clippings about accidents and discuss how they might have been avoided.

SUGGESTED ACTIVITIES	MAJOR IDEAS (GENERALIZATIONS)
What are some accidents common today that were unheard of in the last days of French Canada along the St. Lawrence about two hundred years ago? Discuss this statement: "The cost of automobile accidents alone is believed to be greater than that of operating all the schools in the country." Dull and Mann - Modern Science in our Daily Life, p. 432.	The increase in accidents is due to our congested and fast-moving society.
Break the class into groups and have reports on the causes and prevention of accidents in each of the following situations: (1) The home (include fire and electrical hazards); (2) Traffic (discuss traffic rules and stress their democratic nature); (3) Farm accidents; (4) Industrial accidents; (5) Transportation and travel accidents; (6) Recreation and sports accidents; (7) Alcohol and Driving. Summarize the Study of Accident Causes in chart form or in a tabulated summary. Experiment: Make a simple fire extinguisher (acid and washing soda). A report on the "clover-leaf" type of road intersection designed by road engineers to cut down on accidents. Can you think of other ways to cut down traffic accidents?	Accidents are caused: They do not just happen.

A class essay on "Accident-Public-Enemy No. 1."

Discuss how the city school traffic patrol is an excellent example of individual and community cooperation in our modern scientific age.

Experiment: Have a child run with a burning potato sack on a stick. Then tell what we should do if our clothes catch fire.

Make safety posters or cartoons: e.g. canoeing in safety, care with matches, jay walking, getting off the bus, running a car engine in a garage, diving into shallow water, rainy day precautions.

Debate: Resolved, that it is usually the automobile driver's fault when accidents occur to pedestrians.

Discuss the proper side of the highway on which to walk. Rehearse this.

If possible arrange for the fire chief or traffic cop to come to your school to talk about accidents. The fire chief might allow a small report group to visit the fire station to learn how alarms and signals work.

Have class discussions and practical demonstrations based on reading assignments followed by careful note-book summaries on the first aid treatment for the following: (1) Frost bite; (2) Fainting; (3)Burns and scalds; (4) Sunburn; (5) Cuts; (6) Bruises; (7) Sprains; (8) Fractures; (9) Dislocations; (10) Electric shock; (11) Bleeding, (Artery and vein); (12) Objects in eye and ear; (13) Drowning; (14) Suffocation; (15) Poisons.

When accidents occur, first aid is often vital.

Make a list of articles you would expect to find in a first aid kit, and try to get one set up in your school.

If time permits, boy scout and girl guide members of the class may act as leaders and demonstrate practical experiment work with splints, bandages, and tourniquet. (Ref. First Aid to the Injured. St. John Ambulance Association.)

Have a boy scout tell what tests he must pass to win his Safety badge.

Demonstrate the Schafer method of using artificial respiration.

Write letters to find out the cost of the following: Accident Facts: National Safety Council Inc., Wash. D.C. First Aid: Canadian Red Cross.

TEXTBOOKS AND REFERENCES

The sub-committee in science have made a very careful examination of the newest general science texts, and teachers should experience no difficulty in gathering material for the proposed unit studies, providing text references are made available.

The sub-committee in science is recommending that the Department of Education authorize those books found in the lists of primary references. In order that references for each of the twenty-one unit studies in Grades VII-VIII-IX may be easily consulted, the best references for each of the units are listed in the bibliography. No one series of texts will give complete coverage for all units in any one grade. The primary references will cover most of the units, however.

The primary list will be used as guide books for first reference. In order to solve the unit problem studies, a number of different reference books must be consulted. This course does not lend itself to the single-text-plan of treatment.

More detailed information on certain sections of the course will be required for reports and classroom discussion than is to be found in the primary references. The selection or rejection of information on the grounds of pertinence to the unit in hand is a technique of fundamental importance, requiring an adequate library of science books, which can be built up over a period of years. Full use should be made of textbooks and references used in the previous science courses.

Basic Primary References for Grades VII-VIII-IX

The sub-committee are of the unanimous opinion that guide books for each of the courses for Grades VII-VIII-IX would be very useful. At present no specific text nor series of texts contains the scope of this program. Hence no specific text can yet be recommended for student possession or purchase.

Topics that are to be studied in Grade VII are often found in a Grade V book or a Grade IX book. Certain texts contain material on only two or three units for any particular grade.

The following primary references are considered the most appropriate in dealing with the unit studies for the three grades of the junior high school:

GRADE VII	Treatment
1. OUR WORLD CHANGES (Powers et al)	Includes 3 Gr. VII units
2. UNDERSTANDING OUR UNIVERSE (Carroll - Book 3)	Includes 2 Gr. VII units

3. SCIENCE FOR BETTER LIVING
(Brandwein et al) ..... Includes 1 Gr. VII unit.

(Note: The Unit on "Health Science Through the Ages" is not covered in any of the texts examined.)

GRADE VIII	Treatment
1. UNDERSTANDING OUR UNIVERSE (Carroll - Book 3)	Includes 6 Gr. VIII units.
2. PLANT WORLD (Basic Science Education Series)	Covers 1 Gr. VIII unit.

GRADE IX	Treatment
1. SCIENCE (Davis and Sharpe)	Includes 4 Gr. IX units.
2. SCIENCE FOR BETTER LIVING (Brandwein et al)	Includes 2 Gr. IX units.

(Note: The unit "Plants and Animals Basic to Alberta's Agriculture" will have to be covered by pamphlets specially prepared by the Department of Education, or by free pamphlets from the Provincial and Dominion Departments of Agriculture.)

Special Valuable References:

(a) The Lynde Series (three books): These three books are invaluable in handling of experimental work at the junior high school science level. They are designed on a basis of experimenting with home-made and improvised equipment and are written in an interesting and effective manner. They should be in every school library. They are not texts for students to purchase.

Titles:

SCIENCE EXPERIENCES WITH HOME EQUIPMENT: Lynde, 1936. 226 pages

SCIENCE EXPERIENCES WITH INEXPENSIVE EQUIPMENT: Lynde, 226 pages

SCIENCE EXPERIMENTS WITH 10-CENT STORE EQUIPMENT: Lynde, 1939, 226 pages

(b) An up-to-date 1950 Science Reference Book: A special reference book for the library and not for student purchase; is a well-planned,

dramatically written, and readable text entitled:

SCIENCE FOR BETTER LIVING: Brandwein, Hollingworth, Beck, and Burgess.

This book is especially suited to Grades VIII and IX students, and emphasizes how scientists work in all fields. The book should be in every school library.

(c) THE BASIC SCIENCE EDUCATION SERIES:

These small booklets are very attractively illustrated and well suited to the expanding-concepts plan of unit study organization in this junior high school science course. Many of these booklets fit in well with the actual scope headings of the overall chart. They have been listed in the grade-by-grade references in this section. The sub-committee found that in the treatment of some of the unit studies these booklets are indispensable. This fact is indicated in the reference list when the indispensability factor applies.

(d) When texts used in the previous junior high school science course are found to be suitable in the study of a unit they have been listed in the grade-list of unit study references.

REFERENCE GUIDE FOR GRADE VII UNIT STUDIES

Note: * = Especially valuable

UNIT VII-1: ANIMALS: A BRIEF STUDY AND SIMPLE CLASSIFICATION.

PRIMARY REFERENCES:

* Working With Science, Craig et al, Book 5.
Using Science, Smith & Trafton, Book 3.
Wonderworld of Science, Meister et al, Book 9.

SECONDARY REFERENCES:

* Science Problems, Beauchamp, Book 3.
Discovering Our World, Beauchamp, Book 1.
Science for Better Living, Brandwein et al.

VALUABLE AIDS (The following booklets of the Basic Science Education Series)

* Animal World (Really indispensable)
Insect Friends and Enemies
Reptiles
Animals We Know
Toads and Frogs
Six-Legged Neighbors

Fishes
Birds
Insect Societies
Insects and Their Ways

UNIT VII-2: LIVING THINGS ARE ADAPTED TO THEIR ENVIRONMENT FOR PROTECTION AND FOOD-GETTING

PRIMARY REFERENCES:

* Our World Changes, Powers et al
Using Science, Smith & Trafton
Understanding Our World, Carroll
Exploring Our World, Powers et al

SECONDARY REFERENCES:

Science for Better Living, Brandwein et al
How and Why Experiments, Frazier et al
Science Problems, Beauchamp
Experiences in General Science, Bowers, Sheane

VALUABLE AIDS: (The following booklets of the Basic Science Education Series)

* Adaptation to Environment
Animal Travels
Seeds and Seed Travels
Animals of the Seashore

UNIT VII-3: BEYOND OUR SOLAR SYSTEM

PRIMARY REFERENCES:

Exploring Science, Smith & Trafton
Our World Changes, Powers et al
Going Forward With Science, Craig et al
Science Plans for Tomorrow, Craig et al

SECONDARY REFERENCES:

Discovering Our World, Beauchamp, Book 1
Our Environment, How We Adapt Ourselves to It, Wood & Carpenter
Modern Science in Man's Progress, Dull & Mann
Science Problems, - Book 2, Beauchamp

VALUABLE AIDS: (The following pamphlets: Basic Science Education Series)

* Beyond the Solar System
The Sky Above Us
Superstition or Science

UNIT VII-4: THE STORY OF THE EARTH'S FORMATION

PRIMARY REFERENCES:

The Wonderworld of Science, - Book 7, Meister et al
The Wonderworld of Science, - Book 8, Meister et al
Understanding the Universe, Carroll
Understanding Our Environment, Carroll
Our World Changes, Powers et al
Exploring Our World, Powers et al

SECONDARY REFERENCES:

How and Why Conclusions, Frazier et al
Science Problems, - Book 2, Beauchamp
Our Environment, Its Relation to Us, Wood & Carpenter

VALUABLE AIDS:

(The following pamphlets: Basic Science Education Series.)

Stories Read from the Rocks
Life Through the Ages
Animals of Yesterday

UNIT VII-5: IDENTIFYING SIMPLE MACHINES

PRIMARY REFERENCES:

Using Science, Smith & Trafton
Wonderworld of Science, Book 8
Understanding Our Universe, Carroll
Using Our World, Powers et al
Going Forward With Science, Craig

SECONDARY REFERENCES:

Discovering Our World, Book 2, Beauchamp
Science Problems, Book 3
Science, Davis and Sharpe
How and Why Experiments, Frazier et al
Modern Science in Man's Progress, Dull & Mann

VALUABLE AIDS:

* Machines, (Basic Science Education Series)

UNIT VII-6: MAGNETS AND THEIR USES

PRIMARY REFERENCES:

Wonderworld of Science, Book 6, Meister et al
Understanding Our Universe, Carroll
Working With Science, Craig

SECONDARY REFERENCES:

How and Why Discoveries, Frazier et al
Discovering Our World, Book 1, Beauchamp
Modern Science in Man's Progress, Dull & Mann

VALUABLE AIDS:

* Magnets, (Basic Science Education Series)

UNIT VII-7: HEALTH SCIENCE THROUGH THROUGH THE AGES

PRIMARY REFERENCES:

Using Our World, Powers et al
Using Science, Smith & Trafton
Understanding Our World, Carroll

SECONDARY REFERENCES:

This unit is well dealt with in Across The Ages, (Capen). This book deals with many other phases of Man's Progress Through the Ages and could be well used in Social Studies as well as in this special unit study.

VALUABLE AIDS:

No special additional references.

REFERENCE GUIDE FOR GRADE VIII UNIT STUDIES

UNIT VIII-1: PLANTS: A BRIEF STUDY AND SIMPLE CLASSIFICATION

PRIMARY REFERENCES:

* Working With Science, Craig
Using Science, Smith & Trafton
The Wonderworld of Science, Meister et al

SECONDARY REFERENCES:

Science Problems - Book 3, Beauchamp

VALUABLE AIDS: (The following Basic Science Education Series pamphlets)

* Plant World
Flowers, Fruits and Seeds
Plant Factories

UNIT VIII-2: LIVING THINGS MAKE USE OF OTHER LIVING THINGS AND NON-LIVING THINGS

PRIMARY REFERENCES:

The Wonderworld of Science, - Book 9, Meister et al
The Wonderworld of Science, - Book 7, Meister et al
Understanding Our World, Carroll
Science Plans for Tomorrow, Craig
Understanding Our Universe, Carroll

SECONDARY REFERENCES:

Discovering Our World, - Book 2, Beauchamp
Science Problems, - Book 1, Beauchamp
Discovering Our World, - Book 1, Beauchamp
Our Environment, How We Use and Control It, Wood & Carpenter

VALUABLE AIDS:

* Balance in Nature, Basic Science Education Series
Balance in Nature, Unit Study Book #555
Plant and Animal Partnership, Basic Science Education Series
Living Things, Basic Science Education Series
Hibernation & Migration, Unit Study Book #559
Dependent Plants, Basic Science Education Series

UNIT VIII-3: WITHIN OUR SOLAR SYSTEM

PRIMARY REFERENCES:

Using Science, Smith & Trafton
Enjoying Science, Smith & Trafton
The Wonderworld of Science, - Book 8, Meister et al
Understanding the Universe, Carroll
Understanding Our World, Carroll
Our World Changes, Powers et al

SECONDARY REFERENCES:

Science for Better Living, Brandwein et al
How and Why Discoveries, Frazier et al
Discovering Our World, - Book 3, Beauchamp
Our Environment - How We Adapt Ourselves to It, Wood & Carpenter
Experiences in General Science, Bowers & Sheane
Modern Science in Man's Progress, Dull
Science Problems, - Book 2, Beauchamp

VALUABLE AIDS: (The following Basic Science Education Series)

* The Sun and Its Family
The Earth's Nearest Neighbor
Thermometers, Heat and Cold

UNIT VIII-4: THE EARTH'S "COVER": WEATHER AND EROSION

PRIMARY REFERENCES:

The Wonderworld of Science, - Book 8, Meister et al
The Wonderworld of Science, - Book 6, Meister et al
Understanding Our World, Carroll
Exploring Science, Smith & Trafton
Enjoying Science, Smith & Trafton
The Wonderworld of Science, - Book 7, Meister et al
Understanding the Universe, Carroll

Understanding Our Environment, Carroll
Our World Changes, Powers et al
Exploring Our World, Powers et al
Science Plans for Tomorrow, Craig

SECONDARY REFERENCES:

*Science Problems, - Book 2, Beauchamp
Science for Better Living, Brandwein et al
How and Why Explorations, Frazier et al
How and Why Discoveries, Frazier et al
Discovering Our World, - Book 3, Beauchamp
Modern Science in Our Environment, Dull
Science, Davis and Sharpe
Experiences in General Science, Bowers and Sheane
Our Environment - Its Relation to Us, Wood & Carpenter

VALUABLE AIDS:

The Earth's Changing Surface, Basic Science Education Series
Ask the Weather Man, Basic Science Education Series
The Ways of the Weather, Basic Science Education Series
Weather, Unit Study Book #551
Clouds, Rain and Snow, Basic Science Education Series
The Air About Us, Basic Science Education Series
The Scientist and His Tools, Basic Science Education Series

UNIT VIII-5: MAN'S USE OF ENERGY

PRIMARY REFERENCES:

Using Science, Smith & Trafton
Wonderworld of Science, Book 8, Meister et al
Understanding Our Universe, Carroll
Exploring Our World, Powers et al
Using Our World, Powers et al

SECONDARY REFERENCES:

Science Problems, - Book 3, Beauchamp
Science Problems, - Book 2, Beauchamp

VALUABLE AIDS:

Matter and Molecules, Basic Science Education Series
Gravity, Basic Science Education Series
Heat, Basic Science Education Series

UNIT VIII-6: PRODUCTION OF ELECTRICITY AND ITS DISTRIBUTION IN THE HOME

PRIMARY REFERENCES:

Wonderworld of Science, - Book 9, Meister et al
Wonderworld of Science, - Book 6, Meister et al
Using Science, Smith & Trafton
Understanding Our Universe, Carroll
Understanding Our World, Carroll
Using Our World, Powers et al

SECONDARY REFERENCES:

Discovering Our World, - Book 3, Beauchamp
Our Environment - How We Use and Control It, Wood & Carpenter
Science Problems, - Book 3, Beauchamp
Science, Davis & Sharpe
Modern Science in Man's Progress, Dull

VALUABLE AIDS:

The Magic of Electricity, Unit Study Book #651

UNIT VIII-7: MICRO-ORGANISMS - BENEFICIAL AND HARMFUL

PRIMARY REFERENCES:

Understanding the Universe, Carroll

SECONDARY REFERENCES:

Our Environment - How We Use and Control It, Wood & Carpenter
Discovering Our World, - Book 3, Beauchamp
Science, Davis & Sharpe
* Modern Science in Man's Progress, Dull

VALUABLE AIDS:

Community Health, Basic Science Education Series
Water Supply, Basic Science Education Series
Water, Basic Science Education Series

REFERENCE GUIDE FOR GRADE IX UNIT STUDIES

UNIT IX-1: PLANTS AND ANIMALS BASIC TO ALBERTA'S AGRICULTURE

PRIMARY REFERENCES:

Pamphlets of the Provincial Dept. of Agriculture
Old Agriculture Textbooks that were once used in public and high schools of Alberta

SECONDARY REFERENCES:

None Suggested

VALUABLE AIDS:

Domesticated Animals, Basic Science Education Series
Domesticated Plants, Basic Science Education Series
Man's Use of Plants and Animals, Basic Science Education Series
The Garden and Its Friends, Basic Science Education Series

UNIT IX-2: NATURAL AND ARTIFICIAL IMPROVEMENT OF ECONOMIC PLANTS AND ANIMALS

PRIMARY REFERENCES:

The Wonderworld of Science, - Book 6, Meister et al
Understanding the Universe, Carroll
Using Our World, Powers et al
Using Science, Smith & Trafton
The Wonderworld of Science, - Book 9, Meister et al

SECONDARY REFERENCES:

Science Problems, - Book 3, Beauchamp
Our Environment - How We Use and Control It, Wood & Carpenter
Science, Davis & Sharpe
Science for Better Living, Brandwein et al

VALUABLE AIDS:

*Improving Plant and Animal Life, Unit Study Book #657
New Uses for Farm Products, Unit Study Book #658

UNIT IX-3: THE EARTH'S MOVEMENTS AND RELATION TO TIME-TELLING

PRIMARY REFERENCES:

Understanding The Universe, Carroll
Understanding Our World, Carroll

SECONDARY REFERENCES:

Our Environment - How We Use and Control It, Wood & Carpenter
Our Environment - How We Adapt Ourselves To It "
Science, Davis & Sharpe
Experiences in General Science, Bowers & Sheane
Science Problems, - Book 2, Beauchamp

VALUABLE AIDS:

* Time, Unit Study Book #407

UNIT IX-4: CONSERVATION OF THE EARTH'S RESOURCES

PRIMARY REFERENCES:

Using Our World, Powers et al
Understanding Our Environment, Carroll
Exploring in Science, Craig
Our World Changes, Powers et al

SECONDARY REFERENCES:

How and Why Conclusions, Frazier et al
Our Environment - How We Adapt Ourselves to It, Wood & Carpenter
Science for Better Living, Brandwein et al
Science Problems, - Book 3, Beauchamp
How and Why Experiments, Frazier et al

VALUABLE AIDS:

* Conservation Illustrated, ($1.00) Canadian Nature Magazine
Soil, Basic Science Education Series
Conservation of Soil and Water, Unit Study Book #511
The Earth a Great Storehouse, Basic Science Education Series
Saving Our Wild Life, Basic Science Education Series
Soil, Water, and Man, Basic Science Education Series
Petroleum, Unit Study Book #553
Conservation of Wild Life, Unit Study Book #512

UNIT IX-5: MACHINES, AND THEIR SOCIAL IMPLICATIONS

PRIMARY REFERENCES:

Using Science, Smith & Trafton
The Wonderworld of Science, - Book 8, Meister et al
Using Our World, Powers et al

SECONDARY REFERENCES:

Our Environment - How We Use and Control It, Wood & Carpenter
Science, Davis & Sharpe
Modern Science in Man's Progress, Dull

VALUABLE AIDS:

None suggested

UNIT IX-6: ELECTRICITY IN OUR DAILY LIVING

PRIMARY REFERENCES:

Wonderworld of Science, - Book 9, Meister et al
Using Science, Smith & Trafton
Going Forward With Science, Craig
Science Plans for Tomorrow, Craig
Using Our World, Powers et al

SECONDARY REFERENCES:

Our Environment - How We Use and Control It, Wood & Carpenter
Science, Davis & Sharpe

VALUABLE AIDS:

The Telegraph and Telephone, Unit Study Book #652
Electricity, Basic Science Education Series

UNIT IX-7: ACCIDENTS AND FIRST AID

PRIMARY REFERENCES:

The Wonderworld of Science, - Book 8, Meister et al
Understanding Our World, Carroll
Exploring Science, Smith & Trafton
Understanding Our Environment, Carroll

SECONDARY REFERENCES:

Science for Better Living, Brandwein et al
Modern Science in Our Daily Life, Dull

VALUABLE AIDS:

Fire, Basic Science Education Series
Fire-Fighters, Basic Science Education Series
Fire, Friend and Foe, Basic Science Education Series

TEACHERS' REFERENCES

1. A PROGRAM FOR TEACHING SCIENCE: National Society for the Study of Education. Thirty-first Yearbook, Part I. Public School Publishing Company, Bloomington, Ill., 1932.

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7. SCIENCE IN THE ELEMENTARY SCHOOL: Croxton. McGraw-Hill Book Company, New York, 1937. (Good reading material for junior high school teachers also.)

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MINIMUM APPARATUS, EQUIPMENT, AND MATERIALS FOR THE JUNIOR HIGH SCHOOL SCIENCE COURSE

Because many schools in the larger cities have both Grades VII and VIII in the same school but no Grade IX, the required equipment for Junior High School Science has been drawn up in two separate lists:

LIST "A": Equipment for Grades VII and VIII only.

LIST "B": Additional equipment for Grade IX.

In a school where Grades VII, VIII, and IX exist, all the equipment in List "A" and List "B" will be required.

LIST "A": EQUIPMENT FOR GRADES VII & VIII

ITEM DESCRIPTION	QUANTITY
AMMETER-VOLTMETER	1
AQUARIUM	1
BALL AND RING SET	1
BALLOONS, Toy	1 dozen
BAROMETER, Aneroid	1
BATTERY JAR, Large, 1 gallon	1
BATTERY JAR, Small	1
BEAKERS, Pyrex, 500 cc	4
BEAKERS, Pyrex, 400 cc	6
BEAKERS, Pyrex, 250 cc	6
BEAKERS, Pyrex, 100 cc	6
BEAKER TONGS, 8"	1
BOARD, Approx. 1" x 10" x 4"	1
BOTTLES, Assorted, wide mouth	4
CANDLES	6
CAPILLARY TUBES	1 set
CART, for inclined planes	1
CLAMPS, retort, 6"	4
CLAMPS, rubber tubing	2
COMPASS	1
CONDUCTOMETER	1
CONVECTION CURRENT APPARATUS	1
COPPER PLATE	½ pound
CORK BORER	1
CORKS, Assorted	1 pkg.
CRUCIBLES, 60 mm	2
CRUCIBLE TONGS	1

ITEM DESCRIPTION	QUANTITY
DISTILLATION APPARATUS	1
DOORBELL, Electric	1
DRILL, With bits	1
DRY CELLS	6
ELECTRIC SWITCHES	
ERLENMEYER FLASKS, Pyrex, 250 cc	6
EVAPORATING DISHES, 60 mm	2
FEHLING'S SOLUTION #1	
FEHLING'S SOLUTION #2	
FILTER PAPER, 6"	1 pkg.
FILE, Triangular	1
FLASHLIGHT BULBS AND SOCKETS	3
FLORENCE FLASK, Pyrex, flat bottom, 1000 cc	1
FLORENCE FLASKS, Pyrex, flat bottom, 100 cc	6
FORCEPS, 5"	1
FUNNELS, Glass, 60 mm	2
FUR, cat's	
FUSES, Old	
FUSES, Tin foil	
GLASS PLATES, 4" square	6
GLUE (Can of LePage's)	1
GRADUATES, Cylindrical, 50 cc	1
GRADUATES, Cylindrical, 100 cc	2
HAMMER	1
HYGROMETER	1
INSECT PINS, Assorted	100
IODINE, Small bottle	1
IRON FILINGS	$\frac{1}{2}$ pound
IRON "U", for electromagnet	1
KILLING BOTTLES, insect	
KNITTING NEEDLES, steel	2
LAMPS, Alcohol, or Bunsen Burner	2
LAMP CHIMNEYS	4
LEAD, for wet cell, 5" x 1" x $\frac{1}{4}$"	2 bars
LIMEWATER TABLETS	1 pkg.
LITMUS PAPER, Blue	1 vial
LITMUS PAPER, Red	1 vial
LODESTONE	1
MAGNESIUM RIBBON	2 ounces
MAGNET, Permanent, horseshoe	1
MAGNET, Permanent, bar	2
MAGNIFIER, Glass	
MANGANESE DIOXIDE	$\frac{1}{2}$ pound
MARBLE CHIPS	
MEDICINE DROPPERS	2
MERCURY	2 pounds
METER STICK	1
METHYLENE BLUE	1 ounce
MICROSCOPE, Compound	1
MICROSCOPIC SLIDE GLASSES	12
MOTOR, Troy	1

ITEM DESCRIPTION	QUANTITY
NICHROME ELEMENT, From electric iron	
PITH BALLS	
PLIERS	
PNEUMATIC TROUGH	
POTASSIUM CHLORATE	$\frac{1}{2}$ pound
PULLEY, Double, bakelite, approx. 2"	2
PULLEY, Single, bakelite, approx. 2"	2
PUMP, Force, glass model	1
RETORT STANDS, with 4 rings, 5"	2
ROD, Ebonite	1
ROD, Glass	1
SCALE, Simple spring, graduated in ounces	1
SILK	
SIMPLE ELECTRIC MOTOR	1
STARCH	$\frac{1}{4}$ pound
STOPPERS, Rubber, assorted, solid and holed	
SWITCHES, Electric	2
TABLE SALT	1 pound
TELEGRAPH KEY AND SOUNDER	1
TELESCOPE, Simple	1
TEST TUBE BRUSHES	3
TEST TUBE HOLDERS	3
TEST TUBES, Pyrex, 30 cc	12
TEST TUBES, Pyrex, 4" x $\frac{1}{2}$"	12
TEST TUBE RACK	1
THERMOMETERS, Centigrade, Fahrenheit	4
THERMOMETER, Indoor	1
THISTLE TUBE	3
TORCELLIAN TUBE	1
TOUCH PAPER	1
TUBING, Glass, assorted	2 pounds
TUBING, Rubber, $\frac{1}{4}$" inside	10 feet
TUMBLERS OR JAM JARS	6
WATCH GLASSES	2
WEDGES	
WHEEL AND AXLE STAND	1
WICKS, for alcohol lamps	6
WING TOP, for Bunsen Burner	1
WIRE, Copper, #22, on spool, not insulated	2 pounds
WIRE, Double cotton covered, #24	$\frac{1}{2}$ pound
WIRE, Gauze squares, asbestos centered, 5"	2
WIRE, Magnet, enamelled, #24	$\frac{1}{2}$ pound
WOOD ALCOHOL	1 quart
"Y" CONNECTOR TUBES, Glass	3
ZINC PLATE	

LIST "B": ADDITIONAL EQUIPMENT FOR GRADE IX

All the items listed for Grades VII and VIII and also the following equipment is required for the Grade IX course in science.

ITEM DESCRIPTION	QUANTITY
BAKING SODA	1 pound
BICYCLE PUMP, Old	1
BLOCK AND TACKLE, Model	1
DEFLAGRATING SPOON	1
ELECTRIC IRONS, Old	
ELECTRIC LIGHT BULBS, Old	
ELECTRIC LIGHT SOCKET	1
ELECTROMAGNET	
FLASHLIGHT	1
GLOBE, Earth	1
LIFT PUMP, Model	1
PUMP, Combined pressure and vacuum	1
RADIO TUBES, Old	
STEAM ENGINE, Toy or cross-section model	1
STORAGE BATTERIES	
STORAGE BATTERY, Old	1
SULPHURIC ACID	1 pound
TELEPHONE RECEIVER AND TRANSMITTER	1
WASHING SODA	$\frac{1}{2}$ pound
WINDLASS, Working model	1
WIRE: Picture, braided	1 pkg.

METHOD OF TEACHING
THE JUNIOR HIGH SCHOOL SCIENCE PROGRAM

The Scientific Method of Pursuing Unit Studies:

In all three grades of the junior high school, the three sets of seven unit studies in science are to be explored by means of the scientific method. This is the method employed by the scientist in finding out about nature, about the life of plants and animals, about our earth and the heavenly bodies, and about our improved health. It is the method employed by man in dealing with the problems of his environment. The science program of the junior high school is a research type of experience-learning-situation.

The Trend Toward Unified Learning: (The Unit Study Method)

In the simple social or group living of pioneer days, the adult citizen rarely moved far from the immediate vicinity of the little community of people. His mode of existance was generally peaceful; accidents were infrequent, and when they did occur, they were talked about for a long, long time.

In the schools of the pioneer settlement, the traditional learning consisted of facts to be memorized and monotonous drill under a stern taskmaster, with little or no attention to meanings and relationships to living. Children used up valuable hours in meaningless rote learning and in the mastery of many bits of isolated details.

In today's complex society, the adult lives in a bustling and scientific world. It seems that we must accept the fact that accidents must happen, a sort of chance we must take. The problem of preparing youth for this swift-moving type of life demands that school learnings must become part of their own personal equipment and geared to the business of solving our living problems in a complex society. Educators consider it important for children to learn the techniques of meaningful problem-solving as related both in content and process to the direct experiences of boys, girls, and of adult citizens. They consider that the ability to view the details of science content in relation to large wholes or units of subject matter is more advantageous than to require the mere memorization of answers to questions. In fact such memorization of science material without reference to the larger problem in hand is falling into disrepute as a teaching method.

It is recognized today that children's learnings become senseless if they are forced to learn without understanding such things as the circumference of the earth, the chemical formulae for foods and complex vitamins, the formulae for changing from Centigrade to Fahrenheit temperatures, or in Social Studies, the terms of the British North America Act.

This program proposes the more modern viewpoint of providing meaningful situations in which pupils must think through a series of problems. The teacher's function is to provide the meaningful situation, to set the stage, to arrange conditions so that children may learn with understanding.

This proposed viewpoint does not eliminate the need for planned lessons, drill, class discipline, and the need for rules to govern individual and group conduct. It does, however, center the educative process on the goals and purposes of the learner. Factual learning is not underestimated; it merely appears in a new light.

In schools experimenting with the unit study method, the advantage of meaningful problem-solving with pupils raising issues and seeing answers for themselves, has been clearly demonstrated. This type of learning technique has been given various names in modern educational writings: project teaching, problem-centered teaching, unified learning, units of study, enterprises, core courses, general education courses.

The Stages of Unit Study in General Science:

Many teachers, unfamiliar with the Unit Study Method, view it with apprehension. Viewed simply, there are four stages to a unit study as shown below:

STAGES OF A UNIT (Every unit must have a title and purpose, separate from the stages of the unit.)

Stage 1: THE STARTING or APPROACH
Stage 2: THE WORKING or UNFOLDING SESSION
Stage 3: THE FINISHING or ROUNDING OFF
Stage 4: THE APPRAISING or EVALUATION

The formula is really very simple: 1. STARTING, 2. WORKING, 3. FINISHING, 4. APPRAISING. Let us examine a little more carefully these four simple steps.

1. THE STARTING STAGE:

(a) The Purpose of the Unit: The aim of the unit must first be clear in the teacher's mind and then, under careful direction by the teacher, become evident to all the pupils in the class. The teacher should endeavor to justify the unit study in his own mind by relation to the general and specific aims or objectives of science teaching (pages 18 to 26).

(b) The Approach to the Unit: As far as the pupils are concerned this is really the true starting point of the unit because it involves the arousal of pupil curiosity and interest (motivation).

2. THE WORKING STAGE:

This is the stage of varied activity, of trial-and-error, of experiments, by a group of children, no two of which are alike. It is really the scientific method "in full swing" with full recognition of individual capacities. The teacher should draw from the suggestions in the unit study outlines but other activities will suggest themselves as the work stage proceeds.

The small number of general ideas listed to the right of the suggested activities in the unit study outlines are expected outcomes. They must not be taught to the pupils, but merely suggest the sort of generalized concept or idea that children should have after the unit is finished. Teachers should ask children to tell in their own words in a general sort of way what they have learned. Some of these general ideas may "pop up" or may be asked for by the teacher as the work stage develops. If in a study of the Solar System a child exclaimed "Golly, but stars must be hefty", this is an excellent spontaneous objective but requires a bit of polishing. The teacher's task is to "strike while the iron is hot" and see to it that Jimmy expresses himself in good scientific English. After suggestions and help from other class members the generalization might take the form: "Compared to our Earth stars are of tremendous size and weight".

3. THE FINISHING STAGE: This is when the unit rounds off and when signs of completion appear, because all findings feasible have been achieved. In the unit outlines, no suggestions have been given for rounding off the unit. This culmination feature has been left entirely to the teacher's own initiative and to the imagination of the class. Teachers who have used the enterprise method will have no difficulty with this stage of the unit. In fact, teachers should realize that the unit study method and the enterprise technique have much in common in the scientific treatment of our curriculum.

4. THE APPRAISING STAGE: At this stage teacher and pupils decide on whether or not the learnings, explorings, the habits of work, were really significant or worth while. The following items may receive attention: Summarizing facts and general ideas; deciding on the value of the unit (teacher and pupils together); a resumé of pupil behavior and contribution (discussion by teacher and pupils); conclusions arrived at; conclusions not reached; deciding if the purpose of the unit was achieved; deciding on general ideas gained by the class members and judging their value to boys and girls of junior high school age, and to fathers and mothers in Alberta and Canada; simple oral and written tests.

Suggestions for Handling the Unit Method:

It should be borne in mind at all times that the most ideal paper organization of a science program, or the most thorough outline of a teaching method can in no wise take the place of the efforts of an intelligent, imaginative teacher with an inspiring personality. So too, the forward-looking attitude of a school superintendent, and his appreciation of the broad outcomes of a science program, far outweigh all that can be written in a program of study.

All that the program of study can do is to give guidance, and to reveal a point of view. This direction, coupled with various suggestions regarding content and method, is as much as can be expected from this bulletin. However, the following leads may be helpful. Note that technical terms have been avoided in the discussion which follows and every effort has been made to keep the explanations simple and direct.

1. The General Handling of the Unit: It has been said that the unit study method is an example of the scientific method in group action because of its use in classroom groups. As previously stated the unit should be thought of in terms of four main stages: Starting, Working, Finishing, Appraising.

2. Each Unit of the Program is Given a Number: The numbering of the unit gives it a grade label and an order or scope number for ready reference. If a teacher substitutes a special unit study he should use the equivalent numbering to that in the overall chart on page 31. He should indicate in his school records that he has substituted a unit and record the title. Substituted units should fall in line with the broad or major areas of the scope (see left of overall chart).

3. Each Unit of Study Should Bear a Specific Title: This limits the area of study by actually defining the problem and making it definite. Any selected unit should deal with some phase of the physical, biological, or social environment, viz. Life, The Earth and the Universe, Work-Energy-Machines-Man, and The Science of Health and Safe Living.

4. The Purpose of the Unit Should be Clearly Evident: This clarity of purpose should be real to both teacher and pupils and should answer the simple question: "Why Study the Unit Anyway?"

5. The Approach to the Unit: This is a very important part of the scientific method, viz. to be able to recognize a problem. The students must feel that a problem situation has arisen and that it bears some relationship to the pupils' experience and to his world environment. The teacher must exercise skill in devising ways and means to arouse intelligent curiosity and interest in the unit so that the pupils will feel that the problem has become "their own" personal study and concern.

6. The Objectives of the Unit: In the total consideration of the unit, the teacher must think in terms of the many guide-posts toward which he is striving to direct the attention of his class. (The Four General and the Eight Specific Objectives - pages 19 to 26.) Let us try to make meaningful to the teacher the relation of a unit study to these guide-posts.

   (a) The four broad objectives of social living:
   The teacher should consider how the unit study will help to make the students better informed and more understanding people in their present living and also in their adult years. The students should, in every science unit study, grow and develop as individuals, as members of their group, as budding citizens in a society, and with a job to do in this society of ours.

   (b) The eight specific objectives of science teaching:
   In every science unit study, the students should gain experience in general learnings, in skills and abilities, and in attitudes, appreciations, and interests. These outcomes should be functional (operative) in the student's present living in Alberta and in Canada.

Some teachers are disturbed over this matter of objectives. As the various studies proceed the teacher will detect them "in operation". For example, the principle that "water pressure varies as depth" can be applied in setting up forms for building a concrete dam, but not many people have this experience. However, many young people have noted the pressure effect on their ear drums if they dive into very deep water. This principle also sets the limit at which divers can work under water. Another example: We might discover that "air pressure also varies with depth (of air)". The application of this principle is felt by Albertans when they do mountain climbing in the Rockies, or when they travel to Vancouver, or take a plane trip, or try to boil eggs at high mountain levels.

In the layout of the unit study outlines it would prove too cumbersome and bulky to indicate how each unit can bring about all eight specific objectives of science teaching. The teacher is left to his own resources in this regard.

Generalizations are considered to be a very important outcome of study in any field. In the unit study outlines a few major core thoughts have been suggested. The teacher and pupils may discover others. Generalizations must never be taught. They must be sensed and expressed in words. When a unit is finished, the teacher should try to train pupils to tell in their own words what general ideas they obtained from the unit study.

7. The Working Stage, or Developing the Unit: In the working-out stage of the unit, no attempt has been made in the unit study outlines to "lead" the teacher by the hand through a planned sequence of activities. The units merely reveal a few suggested activities. Teachers may accept, reject, or change any or all of the proposed activities in any unit. Teachers must work out the unit studies with their own class groups, in their own particular localities, remembering always that all children are different, that all class groups are different, that socio-economic and geographic communities are different. Teachers should "cash in" on pupil ideas, and supplement these with their own valuable proposals.

The working or activity stage of the science study is really the part where the unit method is going "full steam", when it is really developing and unfolding. Group and individual tasks get under way. Leaders and committees are working. Data is being gathered and sifted. Ideas pour forth from the minds of busy children. These ideas are evaluated; some are accepted, some rejected.

Experimentation work, because of its objective and practical nature, is an essential skill for chuldren to acquire. Experiments with strong acids or other dangerous materials should be performed by the teacher. In all experimentation work the teacher guides and pupils participate where they can. As much individual and small-group experimentation work is to be carried out as time and facilities will allow.

In developing a topic or in carrying out an experiment the teacher should encourage active discussion. In dealing with science topics or

experiments try to let the pupils get the "feel" for the scientific method. For example:

1. An issue is raised (usually in question form).
2. The teacher or group chairman asks for opinions or guesses (hypotheses).
3. These suggestions are written on the board and evaluated in terms of evidence available.
4. The group propose suggestions to solve the problem: Readings, personal authority, writing for information, experimentation.
5. Individuals or groups (not the teacher) tell what information the experiment revealed; how does it answer the original question?
6. Other evidence is brought to light: other experiments, other experiences, other book references.

Teachers and pupils sum up their findings and record briefly in their notebooks. Suggested headings for experiment reporting are:

a. The problem as defined.
b. The problem investigation.
c. The problem answered.

The new "block system" of time-scheduling calls for one period per week on the Communication Skills in Science. The unit studies will provide opportunities for self-expression, and remedial work if necessary, in both oral and written English in the field of General Science. Attention will be given to accuracy of expression, clearness of explanation of science phenomena, correct usage of science vocabulary, proper spelling of technical words, and correct English form. It is felt that Science can be as effective as Social Studies in the motivation and interrelation of English with other areas of the junior high school program.

8. Student Reporting During the Working Stage: There has been a good deal of criticism of the student report in enterprise teaching and in unit teaching. It is felt that pupils need to be given very careful guidance by the teacher in the preparation and in giving of reports. After reports have been given they should be carefully evaluated by the group and when found wanting the teacher should supplement material and improve on the organization of the report.

In the enterprise and unit study method, the traditional responsibility of the teacher for "handing out" science content is now placed in students' hands. The result of this change in method is for pupils to read, search, study, and report.

Report materials serve as the basis for class discussion. The source of student report material is to be found in magazines, periodicals, newspapers, reference books, experiments, biographies, and their own personal experiences.

The teacher has an important responsibility in regard to the report as an educational method. It is felt that many teachers have not yet made the

most of this very worth-while pupil experience. Teachers should know that pupils are not innately gifted with this specialized type of experience. They need very careful direction and help. It is the teacher's responsibility to help the pupil choose a report topic wisely (it must be within the level of his interest and ability). There must be readily available material on the topic otherwise the child is frustrated in his attempts to gather information. In fact the teacher must be able to suggest reference or source material and direct the child to it. The teacher must instruct the class carefully as to what a report should include. Such directives should come early in the school year.

Criteria for Evaluating a Report: (Ref. Science: Board of Education, N.Y.)

WHAT A REPORT MIGHT INCLUDE

1. A definite clear statement of the topic.
2. A statement of the sources of information.
3. Three, four, or five important facts.
4. Definite evidence or reasons to support each statement.
5. Appropriate diagrams shown to the class or sketched on the board.
6. Possibly an experiment demonstrated to the class, followed by discussion and a clear explanation of principles involved.
7. Slides or pictures shown to the class.

THE POST-REPORT DISCUSSION

1. Teacher or chairman to keep the discussion to the point.
2. Pupils encouraged to ask questions, always maintaining orderly behavior and decorum.

CRITERIA OR STANDARDS FOR EVALUATING THE REPORT

1. Was the report interesting or important?
2. Was the report prepared carefully and thoroughly?
3. What did we learn from the report that we did not know before?
4. What other books, experiments, or illustrations might be used in a later talk on the same subject?

These principles or standards might be posted on the bulletin board or in conspicuous chart form for constant reference by teacher, report leaders, chairman, and reporters.

9. Home Assignments: Home study and research (the term homework suggests drudgery) should be the direct outcome of class work and class activity which goes on in the working stage of the unit. The best type of home assignment is not the note-copying, or note-making-from-book variety, but rather the kind that is searching, challenging, creative, and that develops the child's thinking powers. The assignment should "tie in" with the unit, thus giving it purpose, and resulting in a desire to carry it out.

A home assignment requiring reading for report work and involving the home preparation of the report is definitely a worth-while home activity. Children may even be asked to plan a set-up for an experiment at home, or to make a simple model providing the assignment instructions are definite, not too time-consuming, and within the child's level of maturity.

10. The Teacher's Function in the Working Stage of the Unit: All through the working stage of the unit the teacher is responsible at all times for the important task of directing, helping, teaching, assigning, listening, observing, summing up, and helping with reports, discussions, and activities.

11. The Finishing Stage and Culmination of the Unit: When the unit study is nearing completion and all possible findings have been made, the teacher and pupils discuss how the unit is to be closed off. No definite suggestions have been offered in the unit study outlines. If an interesting and varied accumulation of display materials, written essays, and such-like have been gathered, these might be shown to parents, to another class or school, or to a Home and School Association Meeting. Or a special diary, or running scrap-book, or mural might have been planned to show the sequence of development of the study. Or again, a class might plan a well-made scrap-book for each unit studied in the year, these to be placed in the school library at the end of the year, or exchanged for those prepared in schools in other provinces or countries.

12. Evaluating the Unit: After the unit is complete the class may prepare a summary of important facts learned and list a few major ideas they have gathered. The value and interest of the unit may be appraised by pupils and teacher in a joint discussion. The class might discuss whether scientists still have much to find out about the unit and if they are still working and studying about parts of it.

13. Application of the Unit: After the unit is all cleared away, the teacher might gather the pupils together to see if the unit is interesting and important to youth and adults in Alberta, Canada, and the World.

Summary of Ideas Regarding the Unit Study Method

Although the Junior High School Handbook makes reference to the Unit Study method, certain generalizations about the method are listed below:

1. The Unit Study Plan is recognized as better adapted to achieve the objectives listed on pages 18 to 26 than the recitation of text-learning plan.

2. The Unit Study Plan is a unit of experience, consisting of closely related activities selected to solve the problem situation faced by the learner.

3. The Unit Study Plan suggests a quality of unity. This unity is really the uniformity of the scientific method, viz., defining a problem, planning a solution, and carrying out the plans successfully.

4. The Unit Study Plan calls for continuous teacher-pupil planning of activities. Teacher guidance is very important because the teacher is the one person who best understands the maturity level, background, and personality of the students in his own group.

5. The Unit Study Plan requires on-going revision or change in original plans because new needs arise and pupils bring in new suggestions.

6. The Unit Study Plan requires a variety of instructional materials: books, audio and visual aids, community resource materials, equipment for experiments, and materials for construction work.

7. The Unit Study Plan must be viewed in terms of purpose and interest. The preliminary overview affords an opportunity for the teacher to assess pupil ideas and suggestions relative to launching the unit study.

8. The Unit Study Plan cannot be carried out without adequate source materials and references.

9. The Unit Study Method calls for day-by-day thinking and planning in order that the work will proceed in a worth-while manner.

10. The Unit Study Plan is diametrically opposed to a topical plan of organization which emphasizes detail and facts.

OTHER CLASSROOM PROCEDURES AND MATERIALS

(1) General Science Equipment and the Science Classroom

Special equipment for the teaching of general science is as essential as for the teaching of art and dramatics. The following factors should receive consideration for the adequate handling of general science at the junior high school level:

(a) A science demonstration and experiment desk
(b) Adequate cupboard and storage space
(c) Sufficient work space
(d) A water supply, and, if possible, gas and electricity
(e) Equipment for handling a wide range of activities (see list of recommended materials and equipment, pages 102 to 105).

(2) A Science Corner for Experimentation

This is a worth-while project in any classroom, but especially in rural schools and in those town schools lacking a special science laboratory.

(3) Setting up a School Museum

A well-arranged museum, containing materials made by students and brought from home, will motivate the learner in many of the unit studies.

(4) Experiments and Demonstrations

Both teacher-demonstration and pupil-demonstration of experiments are essential parts of a good science program and both methods of experimentation are of value. It is likely that in order to save time and money, teacher demonstration, rather than individual performance of experiments may be resorted to on occasion.

(5) Home-made Equipment

There is a considerable amount of learning and understanding which results from the manufacture and improvising of home-made equipment. Such items as: a pneumatic trough, retort stands, wire mesh, alcohol lamps, water pressure system for the science corner, graduates, balance, test-tube stands, test-tube holders, test-tube racks, expansion apparatus, may all be improvised by the student directed by an imaginative teacher.

(6) Reports and Summaries

It has been indicated previously that training in clear organization in presentation of ideas is an art that teacher should guide and develop in children. Since students show a great deal of interest in modern invention and discovery, periodic discussion of current events in science should form a part of classroom activities.

Science in the news will furnish an abundance of topics for oral discussion and written work. Newspapers, magazines, and other periodicals are filled with such materials as advertisements of scientific products, articles on food, clothing, and shelter, aerial and sea navigation, improvements in radio and television, Alberta's oil, coal and oil refining in Alberta, prairie pipe-lines for oil and gas, provincial and city departments of health, conventions of medical men or scientists or engineers in Banff, wind erosion in southern Alberta, the St. Mary's irrigation scheme, nylon, control of fire, two-way police radios, Yellowknife gold, T.C.A. service, weather reports in relation to recreation and modern transportation.

(7) A Student Notebook

The student notebook should reflect his own interest and endeavor and should never contain mass dictation of notes by the teacher. The notebook, preferably loose leaf, should contain important summaries of student reports, teacher's summaries of significant information, clippings from periodicals and newspapers, records of experiments, answers to thought questions, simple labelled diagrams, short-answer test items. Long involved science "stories" of performed experiments are too time-consuming and are not justified from the standpoint of writing by the student or correction by the teacher. Elaborate, exact, and artistic drawing of apparatus set-ups and biological specimens is not justified in terms of resultant values to the student. Inking or coloring of "lab" drawings is not considered psychologically sound practice. The practice of having children copy elaborate and detailed drawings from textbooks is to be condemned.

(8) Scrapbooks

This is the type of activity that appeals to certain students, but not to all. The scrapbook should not become a book of scraps. This is an excellent opportunity for the transfer of habits learned in the art class to carry over into the student's science notebook and the class scrapbook.

(9) Workbooks

Student workbooks, if used at all, must be selected with care. The type of workbook that consists entirely of short answers such as single words, short phrases, completing or labelling diagrams, or filling in short-answer observations and conclusions is of doubtful value. A well-designed workbook should contain guidance instructions to the student in order that he may carry out experimental work, research study, and other activities in and out of school.

(10) The Science Club

Such an organization may well take over the arrangements and planning for visits to field and factory, communications with provincial authorities on the formation of calf and swine clubs, and even the direction of a chess-and-checker club.

(11) Bulletin Board or Scrap-boards

The school or classroom bulletin board should contain a section labelled SCIENCE, for current clippings from newspapers and periodicals.

(12) Field Trips or Excursions

In planning an excursion or field trip, three parts are essential: (a) the pre-planning or setting up of the purpose of the trip, (b) the trip itself, (c) the follow-up discussion to sum up what information was gained. Appropriate understandings from excursions to nature's laboratories and to industrial plants will be guaranteed if observation is carefully directed followed by "post-trip-reports".

(13) Collections

Many students show a marked aptitude for collections and such an activity often leads to later life hobbies. Much satisfaction is gained from gathering, planning, mapping out, arranging, labelling, and setting out titles. Pupils may collect soil types, leaves, seeds, plants, rocks, minerals, types of cloth, of wood, of fur, etc.

Audio-Visual Aids:

In the Working Stage of the unit study, visual aids of all types will add to the success of the study. Pupils may make charts, diagrams, mount pictures, watch films and slides. It should be remembered that much more can be learned

from such aids than the mere mechanical business of charting or mounting. Any graphic representation of factual knowledge calls for resultant understandings. Even films, filmstrips and slides must not develop into a "picture-show". All visual aids should be talked about and discussed fully. Films should be shown with a purpose in mind, an aid to answer a question or solve a problem. After the showing, the pupils should decide whether or not the film has served its purpose. This is an excellent opportunity to correlate the summary-discussion or appraisal of science materials with language.

Films and Filmstrips from the Department of Education: Teachers should procure from the Provincial Department of Education and from the University Department of Extension catalogs from which a selection of science films and filmstrips may be made. Such films may be used in the unit study to orient, to clarify, to supplement, and must be selected according to the maturity of the children. Just as a preliminary and post-discussion is needed in a field trip or excursion so too are these essential phases of the use of audio-visual aids. It is hoped that in time divisional libraries will contain a film bureau in order to gain the greatest benefit from the use of films as an aid to teaching.

EVALUATION IN RELATION TO THE UNIT STUDIES

The handbook for junior high school grades deals carefully with the importance of evaluation in relation to unit study procedures. At this point, specific reference is made to a number of principles of evaluation which apply particularly to this program in general science.

Evaluation Principles: (applicable in the field of science study)

1. Evaluation in the field of general science must measure the broad objectives of science instruction.

2. Evaluation in the field of general science must measure or appraise the child's total behavior or reaction to a given science unit or series of unit studies.

3. Evaluation in the field of general science must include techniques other than the traditional paper-and-pencil technique.

4. Evaluation in the field of general science may include problem-situation tests. Such tests are especially well-suited to the field of junior high school general science and measure such factors as: the ability to formulate hypotheses, evaluate data, check judgment against evidence, apply principles, nature of proof. These tests consist of a problem-situation with given information to aid in its solution. After a description of the problem is read by the student, he is asked to decide on a sound course of action.

5. Evaluation in the field of general science should appraise the results of the students' experiences in the units undertaken.

6. A complete evaluation program should in addition to the foregoing test for the following: accurate expression in the language of science, spelling and meaning of science vocabulary.

7. Evaluation in the field of general science should appraise the development of general understandings, skills and abilities, attitudes, appreciations, and interests.

8. Evaluation in the field of general science should include self-appraisal and group evaluation.

   (a) Examples of self-appraisal

   i. Each pupil might prepare a careful sentence outline of the unit telling what it has been about.
   ii. Each pupil might prepare a list of statements illustrating his reaction to certain phases of the unit which impressed him.
   iii. Each pupil might write out three understandings or generalizations and expand them into a short paragraph. These could be read in class followed by group discussion.

(b) Examples of group evaluation (ref. Ogburn)

In order to determine the progress made by pupils, they should be tested for (1) information gained, (2) general understandings, (3) attitudes, (4) other outcomes.

(1) Information test: True-false, best-answer, and completion types of objectives are suitable for this purpose. The essay type may also be used.

Example: Draw a circle around T if the statement is true. Draw a circle around F if the statement is false.

T F The pistil is on the outer part of a flower.
T F Mendel was responsible for drawing up the classification system of plants.
T F The dog is both a mammal and a carnivore.

(2) Understanding test: The multiple-choice or best-answer types of objective test are very suitable for measuring understandings. In setting up tests, answers include one basic understanding, one opposite statement, a partly correct generalization, and a controversial or debatable generalization. The pupil is to identify the correct answer, the incorrect answer, the partly correct answer, and the debatable statement.

Example: Place the letter R before each answer that is right, W before each answer that is wrong, D before the statement that is debatable, and P before each statement that is partly true.

Plants and animals are valuable to man because

..... They should be completely consumed without replacement.
..... They lighten his work burden.
..... They furnish him with food material.
..... They provide coming generations with oil.

(3) Attitude test:

Example: If you agree with the statement and hold the same attitude, place the letter A on the dotted line in front of it; if you do not have the attitude expressed, place the letter D before it; if you cannot make up your mind whether the attitude expresses your point of view or not, place a question mark in front of it.

..... Timber removal from our forests should not be an indiscriminate affair.
..... The government should take over the control of all our natural resources and guarantee that all people share in the returns from them.
..... All Canadians should study the information on production and distribution of our plant and animal products.

..... Private enterprise is unfair because it robs people of the necessities of life obtained from plants and animals.
..... The scientist shows us how to organize knowledge.

(4) Use of films in the evaluation of a unit: In closing off a unit the teacher may procure a film and after it is shown discuss whether or not the unit study has assisted them to better understand the film. (e.g. a 16 mm. silent: "How Life Begins", Nos. Q-42, Q-43, Q-44, Q-45, procurable from the Audio-Visual Aids Branch of the Department of Education.)

(5) Evaluation in terms of objectives: In finally evaluating the unit the teacher should ask himself the following questions:
(a) Does the unit meet the "purpose" set out at the start of the unit?
(b) Does the unit meet the eight specific objectives of general science teaching?
(c) Does the unit meet the four general objectives of education?

(6) The junior high school handbook will make reference to other instruments or appraisal devices such as: the anecdotal record, the day-to-day observation of the pupils, and so on. These will not be referred to here. This is not to slight their importance however, because it is only by means of such observational techniques that the teacher can achieve successfully the evaluation of the more difficult-to-measure outcomes such as attitudes, appreciations, interests, problem-solving skills, and many general understandings.